3. Windows Event Logs & Finding Evil

Windows Event Logs

Windows Event Logging Basics

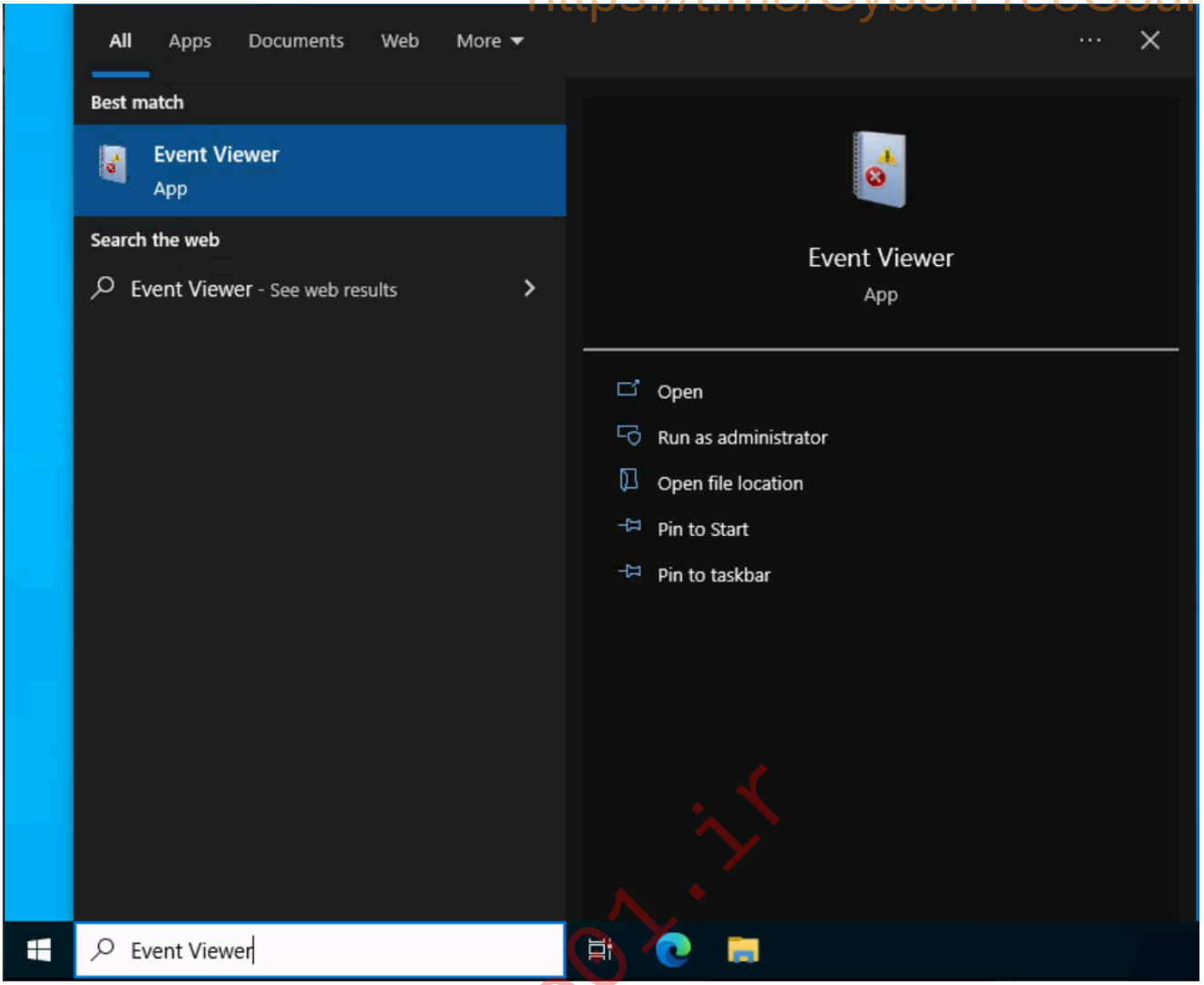
`Windows Event Logs` are an intrinsic part of the Windows Operating System, storing logs from different components of the system including the system itself, applications running on it, ETW providers, services, and others.

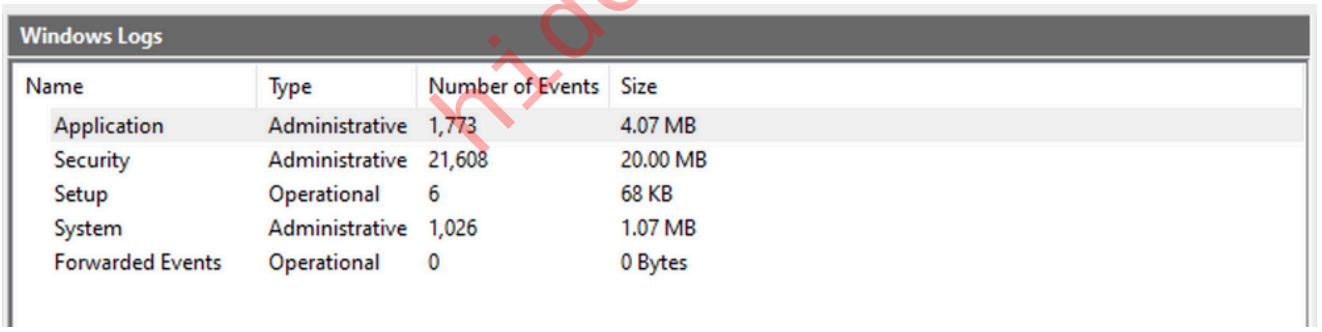
Windows event logging offers comprehensive logging capabilities for application errors, security events, and diagnostic information. As cybersecurity professionals, we leverage these logs extensively for analysis and intrusion detection.

The logs are categorized into different event logs, such as "Application", "System", "Security", and others, to organize events based on their source or purpose.

Event logs can be accessed using the `Event Viewer` application or programmatically using APIs such as the Windows Event Log API.

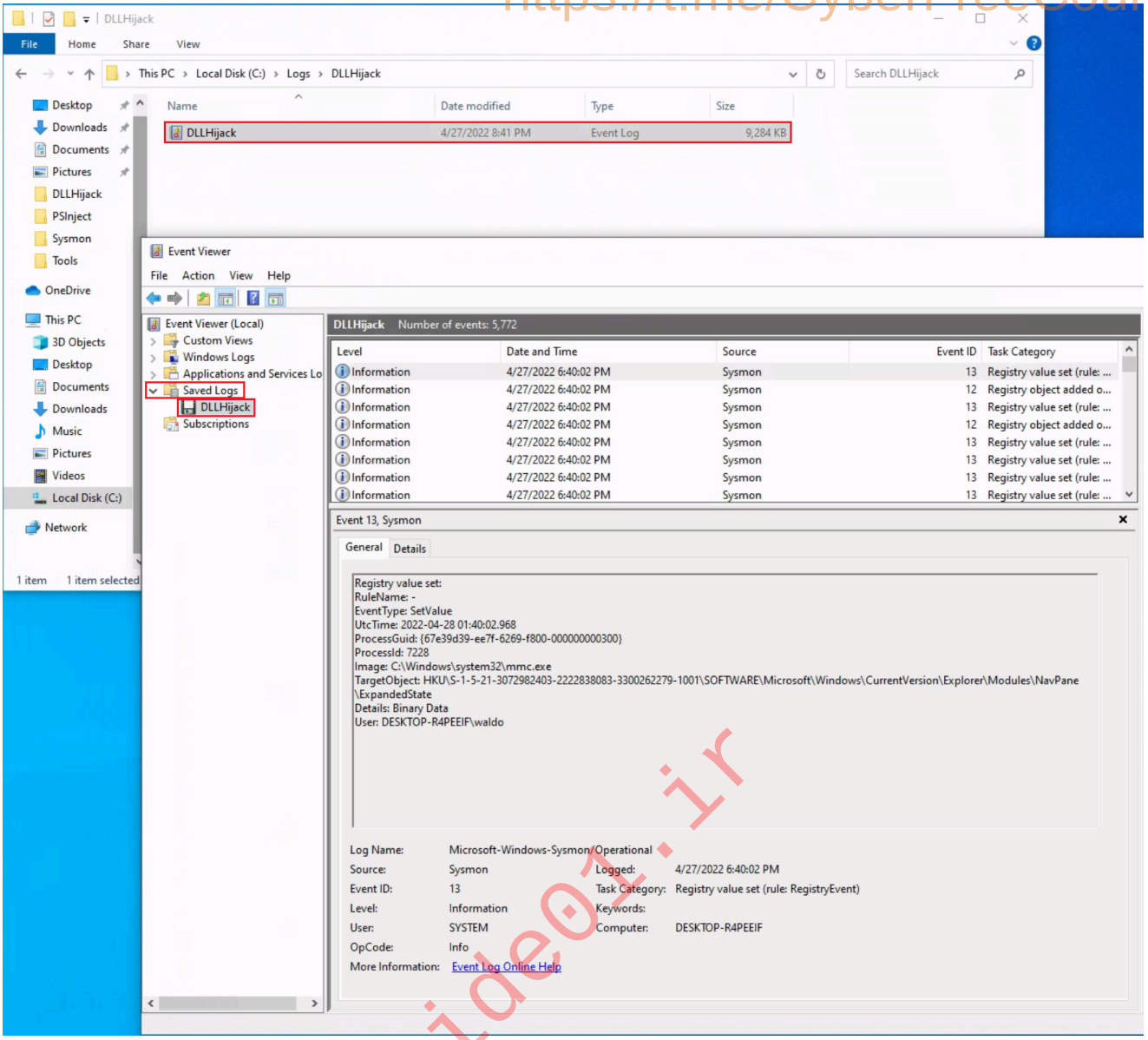
Accessing the `Windows Event Viewer` as an administrative user allows us to explore the various logs available.





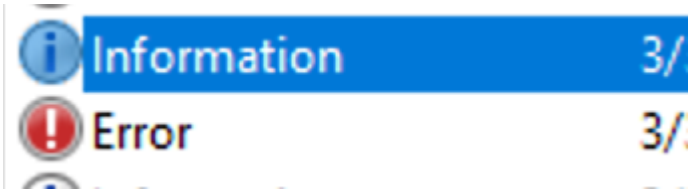
The default Windows event logs consist of `Application`, `Security`, `Setup`, `System`, and `Forwarded Events`. While the first four logs cover application errors, security events, system setup activities, and general system information, the "Forwarded Events" section is unique, showcasing event log data forwarded from other machines. This central logging feature proves valuable for system administrators who desire a consolidated view. In our current analysis, we focus on event logs from a single machine.

It should be noted, that the Windows Event Viewer has the ability to open and display previously saved `.evtx` files, which can be then found in the "Saved Logs" section.

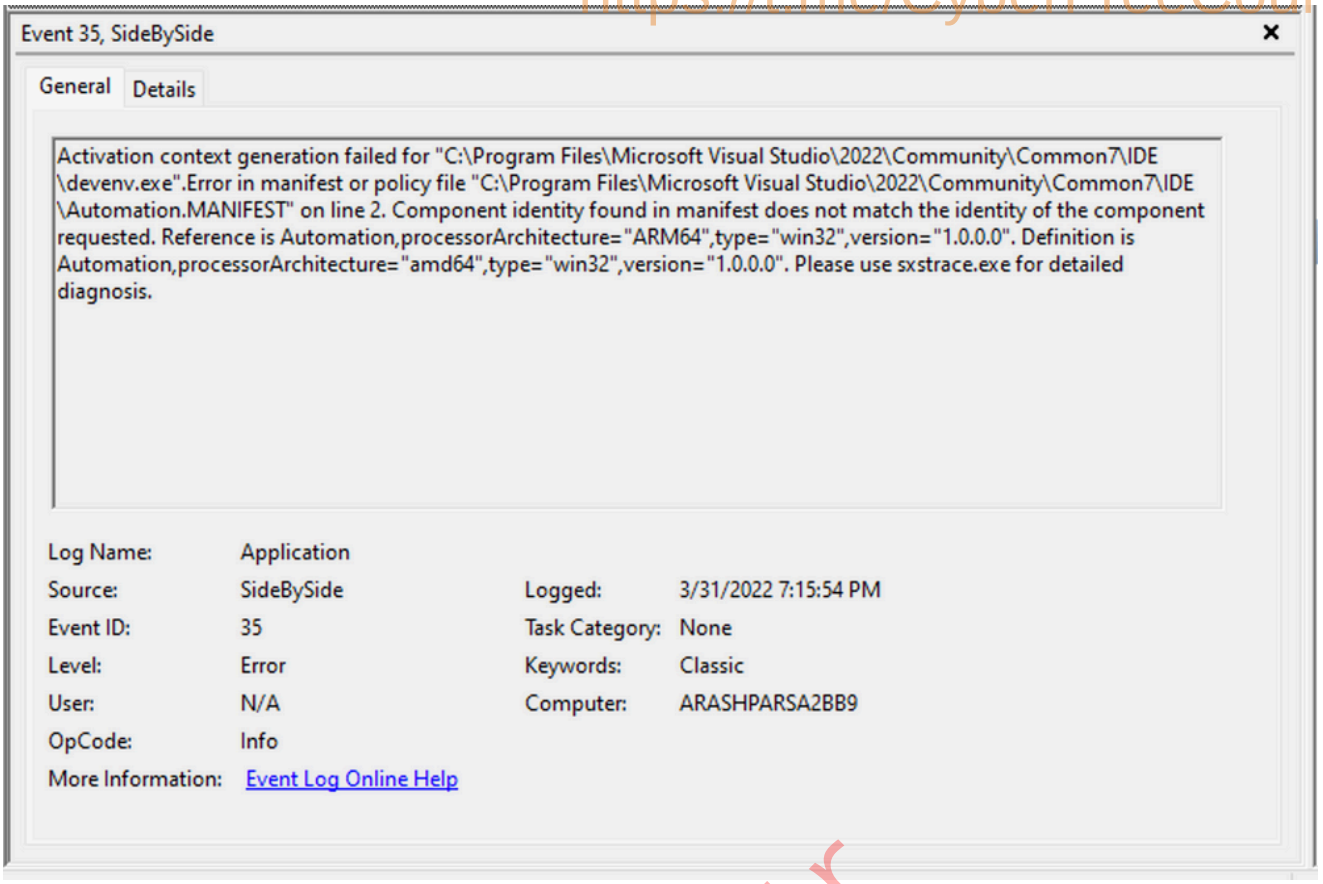


The Anatomy of an Event Log

When examining `Application` logs, we encounter two distinct levels of events: `information` and `error`.



Information events provide general usage details about the application, such as its start or stop events. Conversely, error events highlight specific errors and often offer detailed insights into the encountered issues.

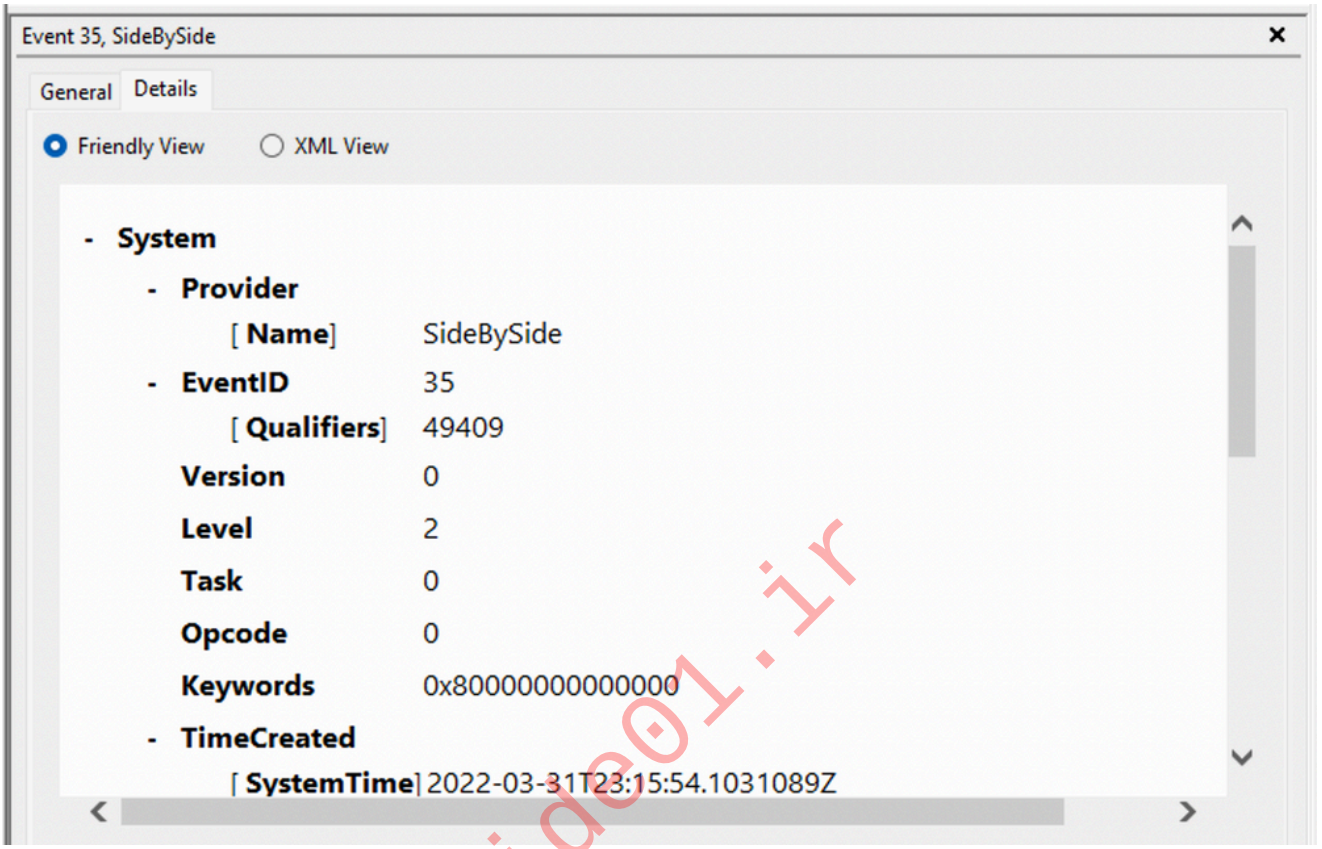


Each entry in the Windows Event Log is an "Event" and contains the following primary components:

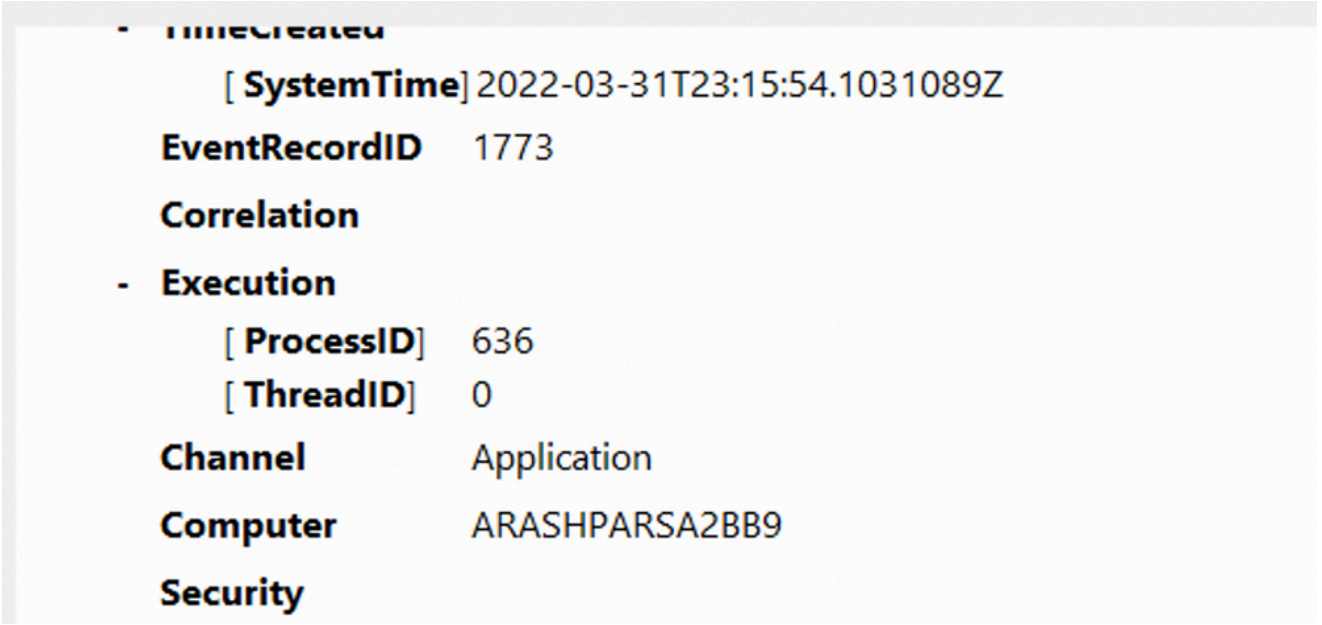
1. `Log Name`: The name of the event log (e.g., Application, System, Security, etc.).
2. `Source`: The software that logged the event.
3. `Event ID`: A unique identifier for the event.
4. `Task Category`: This often contains a value or name that can help us understand the purpose or use of the event.
5. `Level`: The severity of the event (Information, Warning, Error, Critical, and Verbose).
6. `Keywords`: Keywords are flags that allow us to categorize events in ways beyond the other classification options. These are generally broad categories, such as "Audit Success" or "Audit Failure" in the Security log.
7. `User`: The user account that was logged on when the event occurred.
8. `OpCode`: This field can identify the specific operation that the event reports.
9. `Logged`: The date and time when the event was logged.
10. `Computer`: The name of the computer where the event occurred.
11. `XML Data`: All the above information is also included in an XML format along with additional event data.

The `Keywords` field is particularly useful when filtering event logs for specific types of events. It can significantly enhance the precision of search queries by allowing us to specify events of interest, thus making log management more efficient and effective.

Taking a closer look at the event log above, we observe several crucial elements. The `Event ID` in the top left corner serves as a unique identifier, which can be further researched on Microsoft's website to gather additional information. The "SideBySide" label next to the event ID represents the event source. Below, we find the general error description, often containing rich details. By clicking on the details, we can further analyze the event's impact using XML or a well-formatted view.

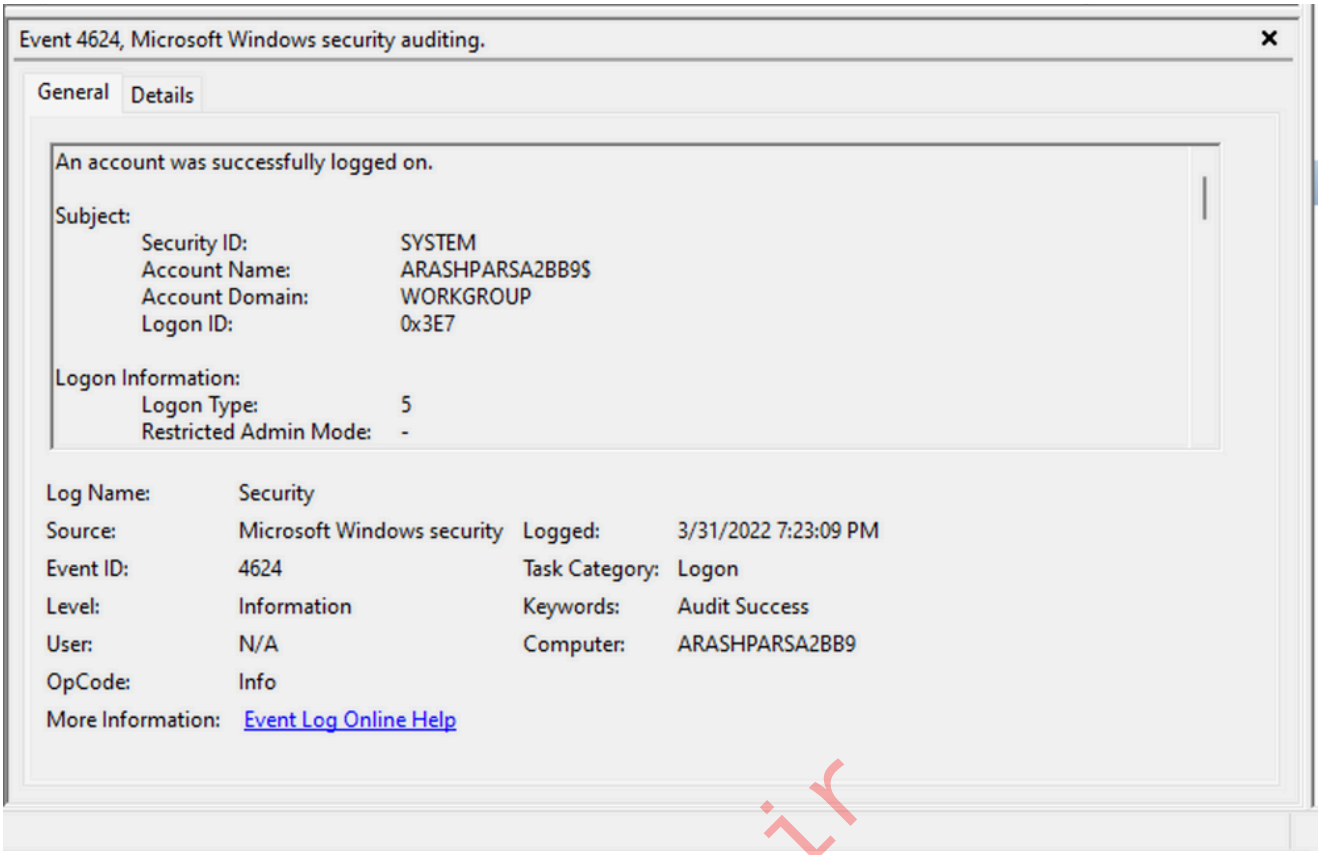


Additionally, we can extract supplementary information from the event log, such as the process ID where the error occurred, enabling more precise analysis.



Switching our focus to security logs, let's consider event ID 4624, a commonly occurring event (detailed at https://docs.microsoft.com/en-us/windows/security/threat-

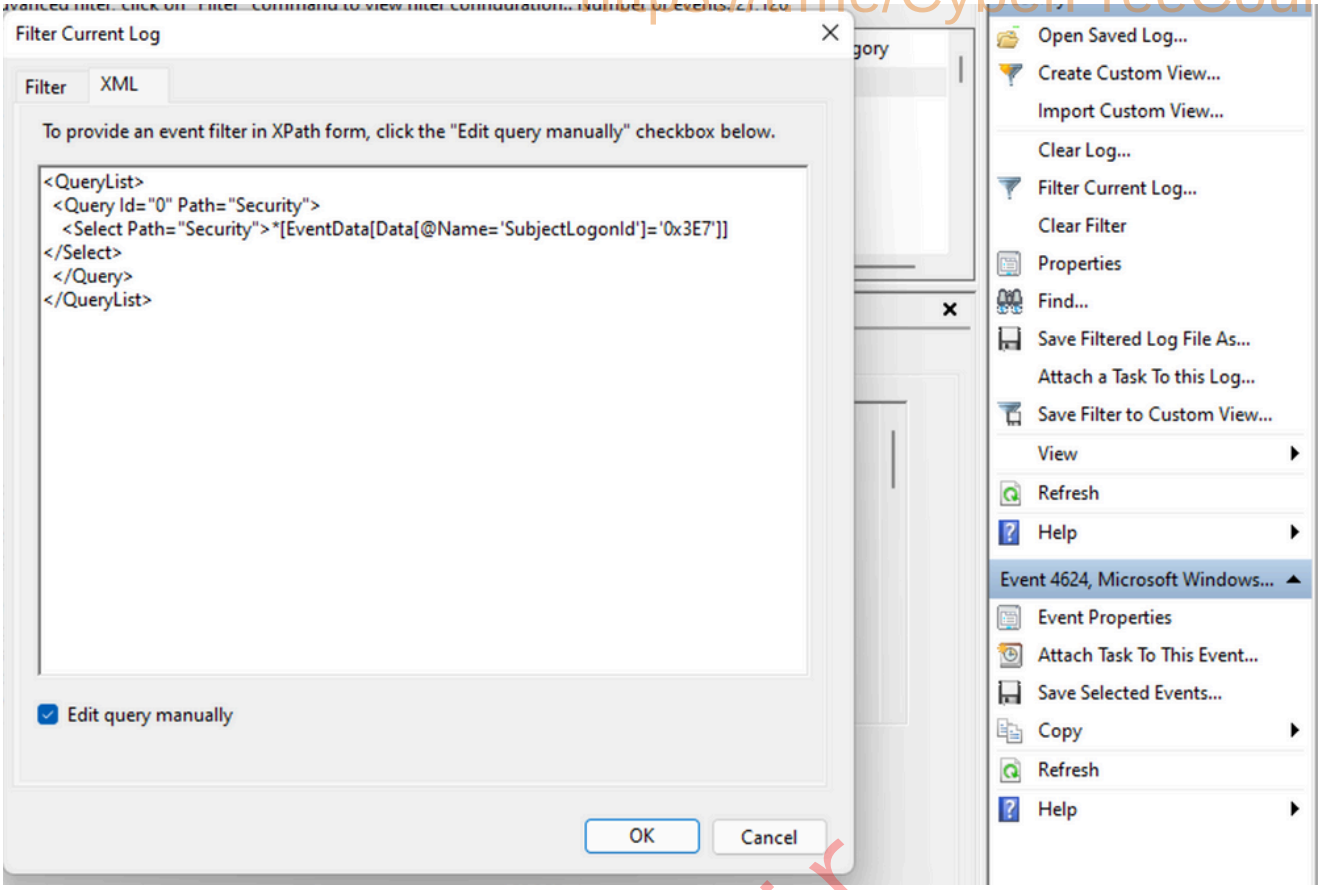
protection/auditing/event-4624).



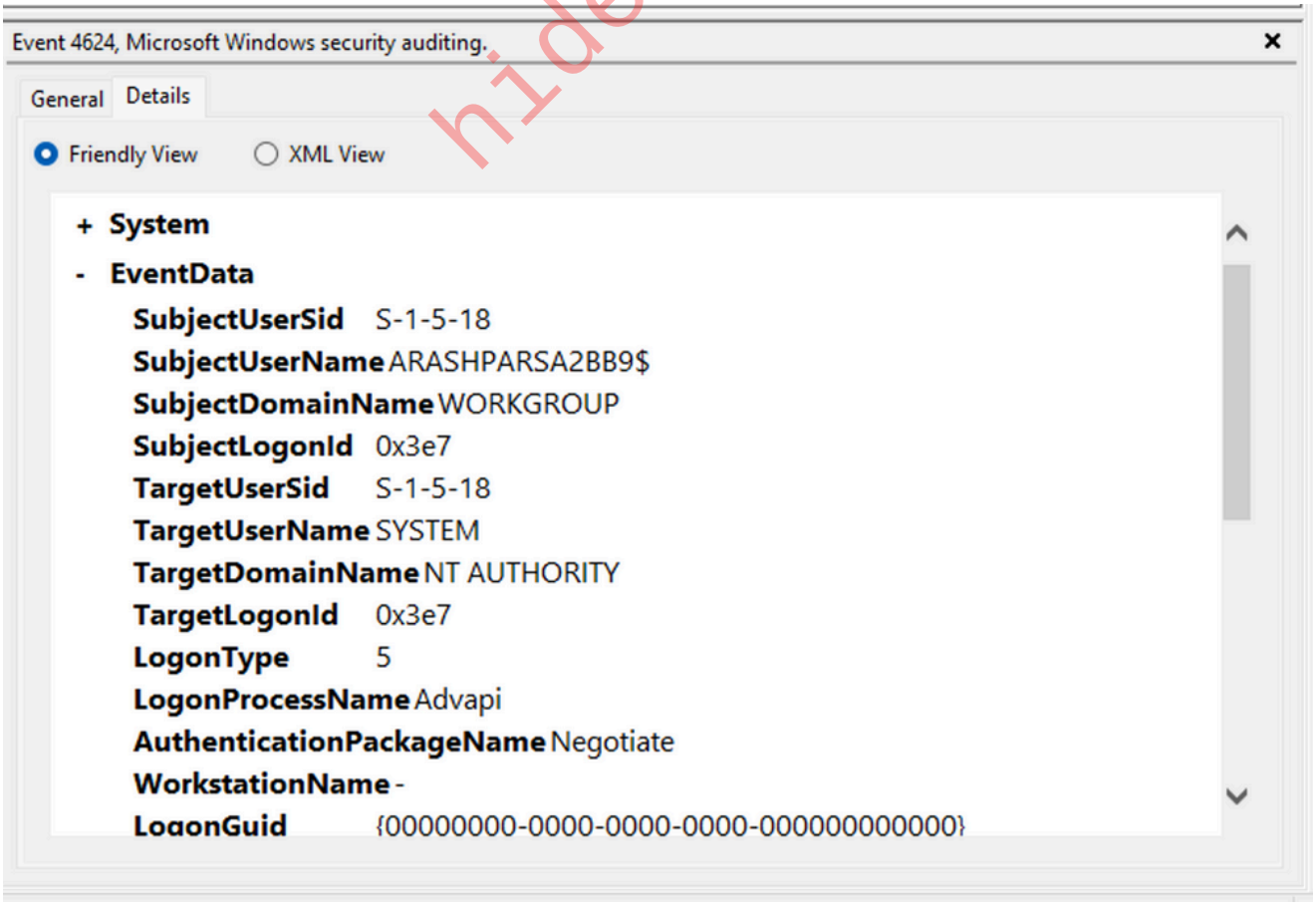
According to Microsoft's documentation, this event signifies the creation of a logon session on the destination machine, originating from the accessed computer where the session was established. Within this log, we find crucial details, including the "Logon ID", which allows us to correlate this logon with other events sharing the same "Logon ID". Another important detail is the "Logon Type", indicating the type of logon. In this case, it specifies a Service logon type, suggesting that "SYSTEM" initiated a new service. However, further investigation is required to determine the specific service involved, utilizing correlation techniques with additional data like the "Logon ID".

Leveraging Custom XML Queries

To streamline our analysis, we can create custom XML queries to identify related events using the "Logon ID" as a starting point. By navigating to "Filter Current Log" -> "XML" -> "Edit Query Manually," we gain access to a custom XML query language that enables more granular log searches.



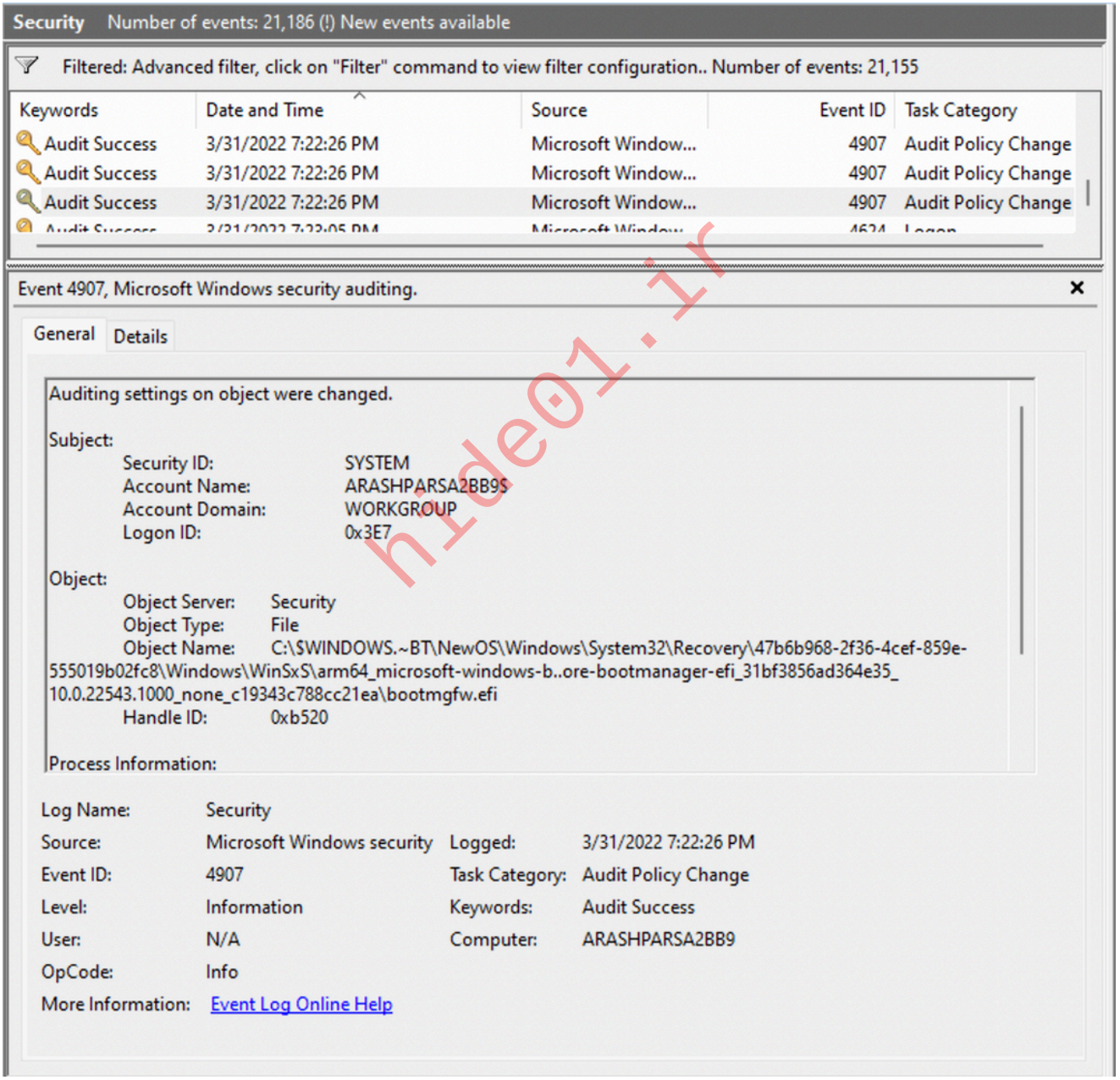
In the example query, we focus on events containing the "SubjectLogonId" field with a value of "0x3E7". The selection of this value stems from the need to correlate events associated with a specific "Logon ID" and understand the relevant details within those events.



It is worth noting that if assistance is required in crafting the query, automatic filters can be enabled, allowing exploration of their impact on the XML representation. For further guidance, Microsoft offers informative articles on advanced XML filtering in the Windows Event Viewer.

By constructing such queries, we can narrow down our focus to the account responsible for initiating the service and eliminate unnecessary details. This approach helps unveil a clearer picture of recent logon activities associated with the specified Logon ID. However, even with this refinement, the amount of data remains significant.

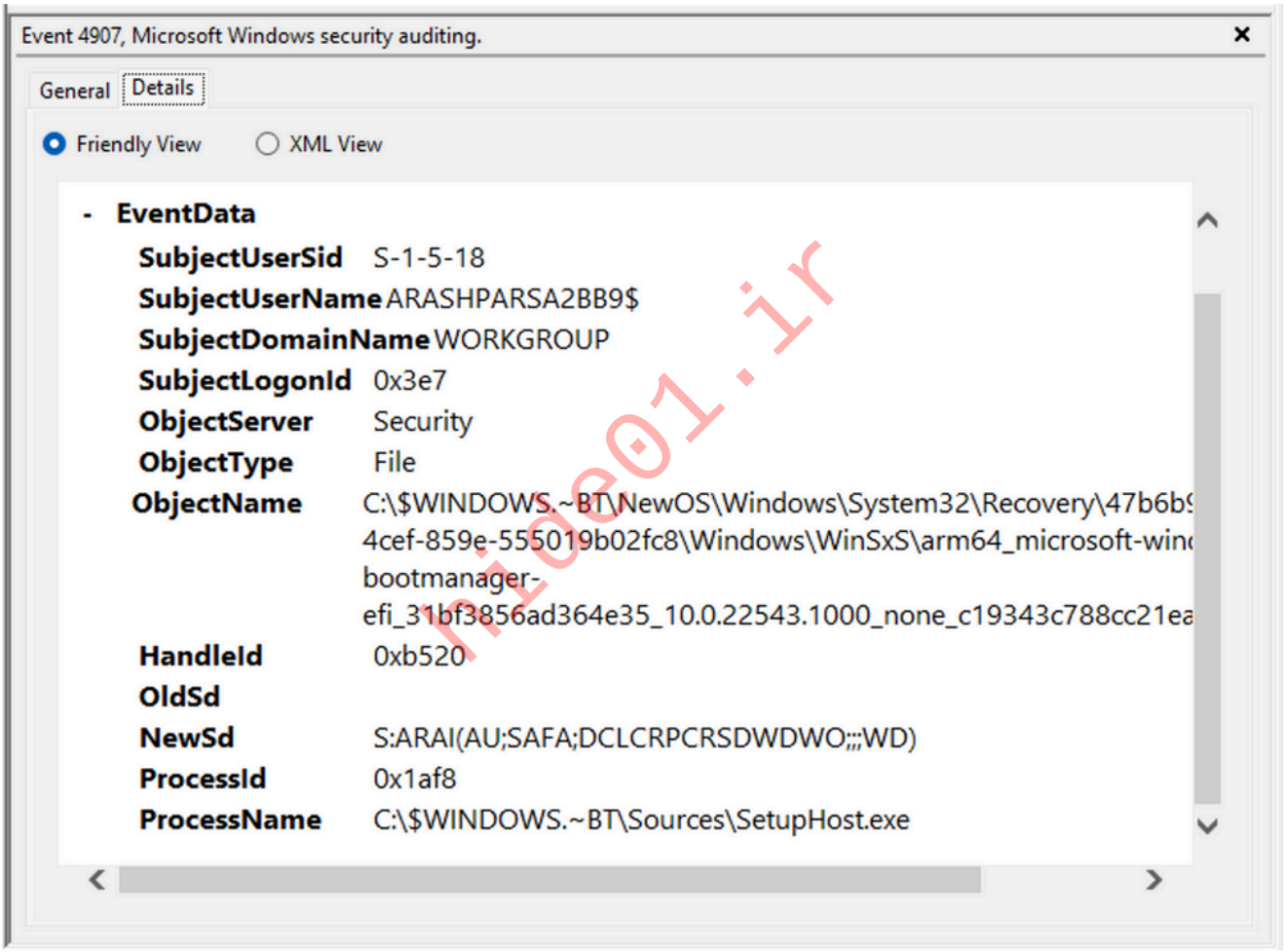
Delving into the log details progressively reveals a narrative. For instance, the analysis begins with Event ID 4907, which signifies an audit policy change.



Within the event description, we find valuable insights, such as "This event generates when the SACL of an object (for example, a registry key or file) was changed."

In case unfamiliar with SACL, referring to the provided link (https://docs.microsoft.com/en-us/windows/win32/secauthz/access-control-lists) sheds light on access control lists (ACLs). The "S" in SACL denotes a system access control list, which enables administrators to log access attempts to secure objects. Each Access Control Entry (ACE) within a SACL specifies the types of access attempts by a designated trustee that trigger record generation in the security event log. ACEs in a SACL can generate audit records upon failed, successful, or both types of access attempts. For more information about SACLs, see Audit Generation and SACL Access Right."

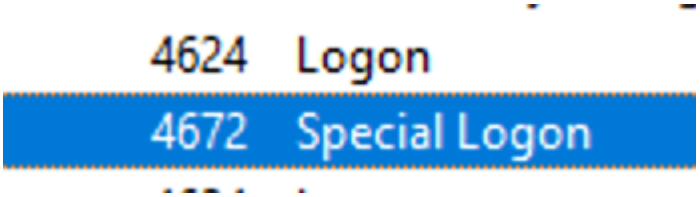
Based on this information, it becomes apparent that the permissions of a file were altered to modify the logging or auditing of access attempts. Further exploration of the event details reveals additional intriguing aspects.



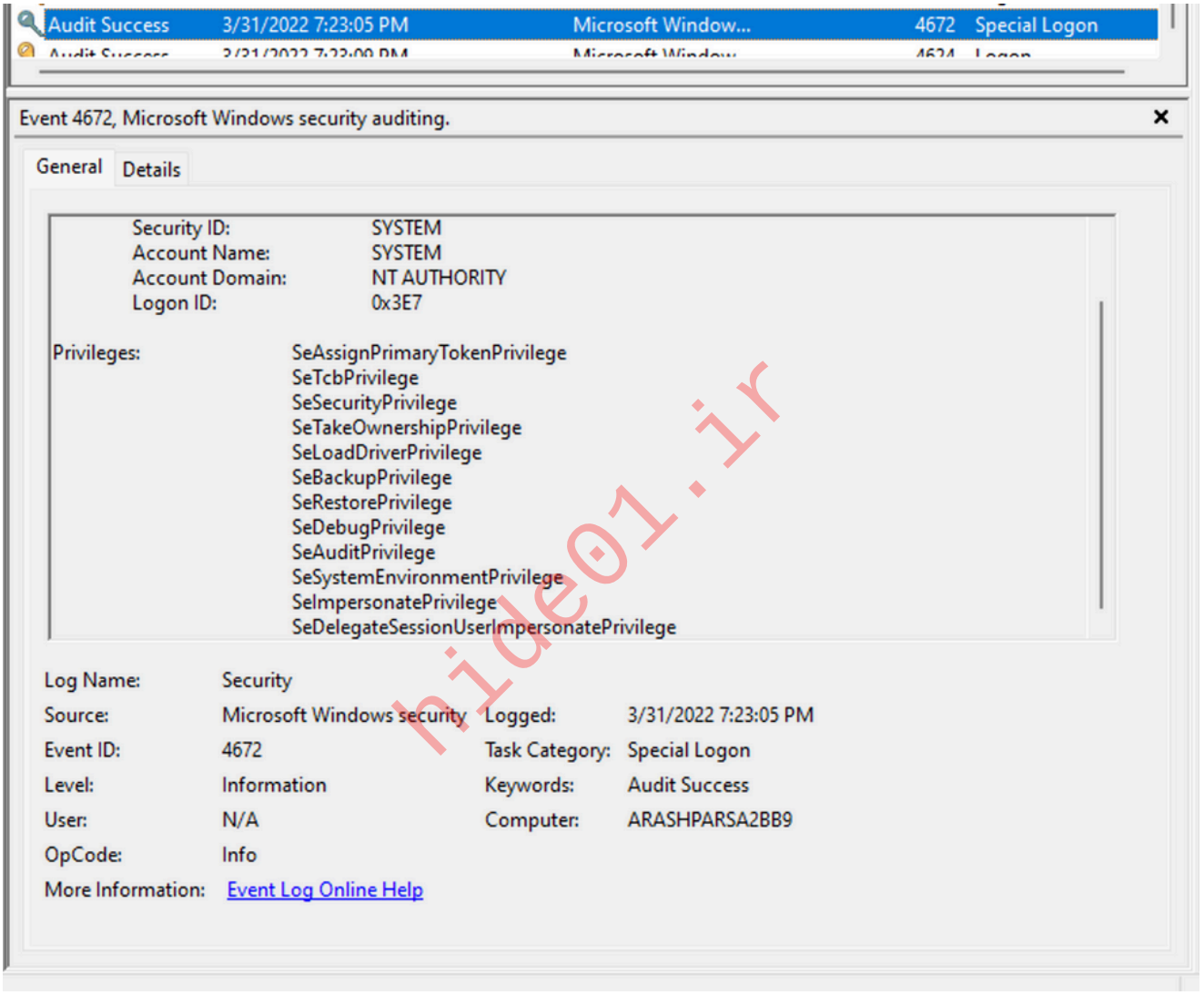
For example, the process responsible for the change is identified as "SetupHost.exe", indicating a potential setup process (although it's worth noting that malware can sometimes masquerade under legitimate names). The object name impacted appears to be the "bootmanager", and we can examine the new and old security descriptors ("NewSd" and "OldSd") to identify the changes. Understanding the meaning of each field in the security descriptor can be accomplished through references such as the article ACE Strings and Understanding SDDL Syntax.

From the observed events, we can infer that a setup process occurred, involving the creation of a new file and the initial configuration of security permissions for auditing purposes.

Subsequently, we encounter the logon event, followed by a "special logon" event.



Analyzing the special logon event, we gain insights into token permissions granted to the user upon a successful logon.



A comprehensive list of privileges can be found in the documentation on privilege constants. For instance, the "SeDebugPrivilege" privilege indicates that the user possesses the ability to tamper with memory that does not belong to them.

Useful Windows Event Logs

Find below an indicative (non-exhaustive) list of useful Windows event logs.

1. **Windows System Logs**

- Event ID 1074 `(System Shutdown/Restart)`: This event log indicates when and why the system was shut down or restarted. By monitoring these events, you can determine if there are unexpected shutdowns or restarts, potentially revealing malicious activity such as malware infection or unauthorized user access.
- Event ID 6005 `(The Event log service was started)`: This event log marks the time when the Event Log Service was started. This is an important record, as it can signify a system boot-up, providing a starting point for investigating system performance or potential security incidents around that period. It can also be used to detect unauthorized system reboots.
- Event ID 6006 `(The Event log service was stopped)`: This event log signifies the moment when the Event Log Service was stopped. It is typically seen when the system is shutting down. Abnormal or unexpected occurrences of this event could point to intentional service disruption for covering illicit activities.
- Event ID 6013 `(Windows uptime)`: This event occurs once a day and shows the uptime of the system in seconds. A shorter than expected uptime could mean the system has been rebooted, which could signify a potential intrusion or unauthorized activities on the system.
- Event ID 7040 `(Service status change)`: This event indicates a change in service startup type, which could be from manual to automatic or vice versa. If a crucial service's startup type is changed, it could be a sign of system tampering.

2. **Windows Security Logs**
   - Event ID 1102 `(The audit log was cleared)`: Clearing the audit log is often a sign of an attempt to remove evidence of an intrusion or malicious activity.
   - Event ID 1116 `(Antivirus malware detection)`: This event is particularly important because it logs when Defender detects a malware. A surge in these events could indicate a targeted attack or widespread malware infection.
   - Event ID 1118 `(Antivirus remediation activity has started)`: This event signifies that Defender has begun the process of removing or quarantining detected malware. It's important to monitor these events to ensure that remediation activities are successful.
   - Event ID 1119 `(Antivirus remediation activity has succeeded)`: This event signifies that the remediation process for detected malware has been successful. Regular monitoring of these events will help ensure that identified threats are effectively neutralized.
   - Event ID 1120 `(Antivirus remediation activity has failed)`: This event is the counterpart to 1119 and indicates that the remediation process has failed. These events should be closely monitored and addressed immediately to ensure threats are effectively neutralized.
   - Event ID 4624 `(Successful Logon)`: This event records successful logon events. This information is vital for establishing normal user behavior. Abnormal behavior, such as logon attempts at odd hours or from different locations, could signify a potential security threat.

- Event ID 4625 `(Failed Logon)`: This event logs failed logon attempts. Multiple failed logon attempts could signify a brute-force attack in progress.
- Event ID 4648 `(A logon was attempted using explicit credentials)`: This event is triggered when a user logs on with explicit credentials to run a program. Anomalies in these logon events could indicate lateral movement within a network, which is a common technique used by attackers.
- Event ID 4656 `(A handle to an object was requested)`: This event is triggered when a handle to an object (like a file, registry key, or process) is requested. This can be a useful event for detecting attempts to access sensitive resources.
- Event ID 4672 `(Special Privileges Assigned to a New Logon)`: This event is logged whenever an account logs on with super user privileges. Tracking these events helps to ensure that super user privileges are not being abused or used maliciously.
- Event ID 4698 `(A scheduled task was created)`: This event is triggered when a scheduled task is created. Monitoring this event can help you detect persistence mechanisms, as attackers often use scheduled tasks to maintain access and run malicious code.
- Event ID 4700 & Event ID 4701 `(A scheduled task was enabled/disabled)`: This records the enabling or disabling of a scheduled task. Scheduled tasks are often manipulated by attackers for persistence or to run malicious code, thus these logs can provide valuable insight into suspicious activities.
- Event ID 4702 `(A scheduled task was updated)`: Similar to 4698, this event is triggered when a scheduled task is updated. Monitoring these updates can help detect changes that may signify malicious intent.
- Event ID 4719 `(System audit policy was changed)`: This event records changes to the audit policy on a computer. It could be a sign that someone is trying to cover their tracks by turning off auditing or changing what events get audited.
- Event ID 4738 `(A user account was changed)`: This event records any changes made to user accounts, including changes to privileges, group memberships, and account settings. Unexpected account changes can be a sign of account takeover or insider threats.
- Event ID 4771 `(Kerberos pre-authentication failed)`: This event is similar to 4625 (failed logon) but specifically for Kerberos authentication. An unusual amount of these logs could indicate an attacker attempting to brute force your Kerberos service.
- Event ID 4776 `(The domain controller attempted to validate the credentials for an account)`: This event helps track both successful and failed attempts at credential validation by the domain controller. Multiple failures could suggest a brute-force attack.

- Event ID 5001 `(Antivirus real-time protection configuration has changed)`: This event indicates that the real-time protection settings of Defender have been modified. Unauthorized changes could indicate an attempt to disable or undermine the functionality of Defender.
- Event ID 5140 `(A network share object was accessed)`: This event is logged whenever a network share is accessed. This can be critical in identifying unauthorized access to network shares.
- Event ID 5142 `(A network share object was added)`: This event signifies the creation of a new network share. Unauthorized network shares could be used to exfiltrate data or spread malware across a network.
- Event ID 5145 `(A network share object was checked to see whether client can be granted desired access)`: This event indicates that someone attempted to access a network share. Frequent checks of this sort might indicate a user or a malware trying to map out the network shares for future exploits.
- Event ID 5157 `(The Windows Filtering Platform has blocked a connection)`: This is logged when the Windows Filtering Platform blocks a connection attempt. This can be helpful for identifying malicious traffic on your network.
- Event ID 7045 `(A service was installed in the system)`: A sudden appearance of unknown services might suggest malware installation, as many types of malware install themselves as services.

Remember, one of the key aspects of threat detection is having a good understanding of what is "normal" in our environment. Anomalies that might indicate a threat in one environment could be normal behavior in another. It's crucial to tune our monitoring and alerting systems to our environment to minimize false positives and make real threats easier to spot. In addition, it's essential to have a centralized log management solution in place that can collect, parse, and alert on these events in real-time. Regularly monitoring and reviewing these logs can help in early detection and mitigation of threats. Lastly, we need to make sure to correlate these logs with other system and security logs to get a more holistic view of the security events in our environment.

Practical Exercises

Navigate to the bottom of this section and click on `Click here to spawn the target system!`

Now, RDP to `[Target IP]` using the provided credentials, open Windows Event Viewer, and answer the questions below.

```
xfreerdp /u:Administrator /p:'HTB_@cad3my_lab_W1n10_r00t!@0' /v:[Target IP] /dynamic-resolution
```

Analyzing Evil With Sysmon & Event Logs

In our pursuit of robust cybersecurity, it is crucial to understand how to identify and analyze malicious events effectively. Building upon our previous exploration of benign events, we will now delve into the realm of malicious activities and discover techniques for detection.

Sysmon Basics

When investigating malicious events, several event IDs serve as common indicators of compromise. For instance, `Event ID 4624` provides insights into new logon events, enabling us to monitor and detect suspicious user access and logon patterns. Similarly, `Event ID 4688` furnishes information about newly created processes, aiding the identification of unusual or malicious process launches. To enhance our event log coverage, we can extend the capabilities by incorporating Sysmon, which offers additional event logging capabilities.

`System Monitor (Sysmon)` is a Windows system service and device driver that remains resident across system reboots to monitor and log system activity to the Windows event log. Sysmon provides detailed information about process creation, network connections, changes to file creation time, and more.

Sysmon's primary components include:

- A Windows service for monitoring system activity.
- A device driver that assists in capturing the system activity data.
- An event log to display captured activity data.

Sysmon's unique capability lies in its ability to log information that typically doesn't appear in the Security Event logs, and this makes it a powerful tool for deep system monitoring and cybersecurity forensic analysis.

Sysmon categorizes different types of system activity using event IDs, where each ID corresponds to a specific type of event. For example, `Event ID 1` corresponds to "Process Creation" events, and `Event ID 3` refers to "Network Connection" events. The full list of Sysmon event IDs can be found here.

For more granular control over what events get logged, Sysmon uses an XML-based configuration file. The configuration file allows you to include or exclude certain types of events based on different attributes like process names, IP addresses, etc. We can refer to popular examples of useful Sysmon configuration files:

- For a comprehensive configuration, we can visit: https://github.com/SwiftOnSecurity/sysmon-config. <-- `We will use this one in this section!`
- Another option is: https://github.com/olafhartong/sysmon-modular, which provides a modular approach.

To get started, you can install Sysmon by downloading it from the official Microsoft documentation (https://docs.microsoft.com/en-us/sysinternals/downloads/sysmon). Once downloaded, open an administrator command prompt and execute the following command to install Sysmon.

```
C:\Tools\Sysmon> sysmon.exe -i -accepteula -h md5,sha256,imphash -l -n
```

```
C:\Users\Waldo\Desktop\Sysmon>sysmon.exe -i -accepteula -h md5,sha256,imphash -l -n


System Monitor v13.33 - System activity monitor
By Mark Russinovich and Thomas Garnier
Copyright (C) 2014-2022 Microsoft Corporation
Using libxml2. libxml2 is Copyright (C) 1998-2012 Daniel Veillard. All Rights Reserved.
Sysinternals - www.sysinternals.com

Sysmon installed.
SysmonDrv installed.
Starting SysmonDrv.
SysmonDrv started.
Starting Sysmon..
Sysmon started.
```


To utilize a custom Sysmon configuration, execute the following after installing Sysmon.

```
C:\Tools\Sysmon> sysmon.exe -c filename.xml
```

Note: It should be noted that Sysmon for Linux also exists.

Detection Example 1: Detecting DLL Hijacking

In our specific use case, we aim to detect a DLL hijack. The Sysmon event log IDs relevant to DLL hijacks can be found in the Sysmon documentation (https://docs.microsoft.com/en-us/sysinternals/downloads/sysmon). To detect a DLL hijack, we need to focus on `Event Type 7`, which corresponds to module load events. To achieve this, we need to modify the `sysmonconfig-export.xml` Sysmon configuration file we downloaded from https://github.com/SwiftOnSecurity/sysmon-config.

By examining the modified configuration, we can observe that the "include" comment signifies events that should be included.

```
<RuleGroup name="" groupRelation="or">
        <ImageLoad onmatch="include">
                <!--NOTE: Using "include" with no rules means nothing in this section will be logged-->
        </ImageLoad>
</RuleGroup>
```

In the case of detecting DLL hijacks, we change the "include" to "exclude" to ensure that nothing is excluded, allowing us to capture the necessary data.

```
<RuleGroup name="" groupRelation="or">
        <ImageLoad onmatch="exclude">
                <!--NOTE: Using "include" with no rules means nothing in this section will be logged-->
        </ImageLoad>
</RuleGroup>
```

To utilize the updated Sysmon configuration, execute the following.

```
C:\Tools\Sysmon> sysmon.exe -c sysmonconfig-export.xml
```

```
C:\Users\Waldo\Desktop\Sysmon>Sysmon.exe -c sysmonconfig-export.xml


System Monitor v13.33 - System activity monitor
By Mark Russinovich and Thomas Garnier
Copyright (C) 2014-2022 Microsoft Corporation
Using libxml2. libxml2 is Copyright (C) 1998-2012 Daniel Veillard. All Rights Reserved.
Sysinternals - www.sysinternals.com

Loading configuration file with schema version 4.50
Sysmon schema version: 4.81
Configuration file validated.
Configuration updated.
```


With the modified Sysmon configuration, we can start observing image load events. To view these events, navigate to the Event Viewer and access "Applications and Services" -> "Microsoft" -> "Windows" -> "Sysmon." A quick check will reveal the presence of the targeted event ID.

Level	Date and Time	Source	Event ID	Task Category
Information	4/7/2022 6:21:35 PM	Sysmon	7	Image loaded (rule: ImageLoad)
Information	4/7/2022 6:21:35 PM	Sysmon	7	Image loaded (rule: ImageLoad)
Information	4/7/2022 6:21:35 PM	Sysmon	7	Image loaded (rule: ImageLoad)
Information	4/7/2022 6:21:33 PM	Sysmon	7	Image loaded (rule: ImageLoad)
Information	4/7/2022 6:21:33 PM	Sysmon	7	Image loaded (rule: ImageLoad)
Information	4/7/2022 6:21:33 PM	Sysmon	7	Image loaded (rule: ImageLoad)
Information	4/7/2022 6:21:22 PM	Sysmon	7	Image loaded (rule: ImageLoad)
Information	4/7/2022 6:21:22 PM	Sysmon	7	Image loaded (rule: ImageLoad)
Information	4/7/2022 6:21:22 PM	Sysmon	7	Image loaded (rule: ImageLoad)
Information	4/7/2022 6:21:22 PM	Sysmon	7	Image loaded (rule: ImageLoad)
Information	4/7/2022 6:21:22 PM	Sysmon	7	Image loaded (rule: ImageLoad)
Information	4/7/2022 6:21:22 PM	Sysmon	7	Image loaded (rule: ImageLoad)
Information	4/7/2022 6:21:22 PM	Sysmon	7	Image loaded (rule: ImageLoad)
Information	4/7/2022 6:21:22 PM	Sysmon	7	Image loaded (rule: ImageLoad)
Information	4/7/2022 6:21:22 PM	Sysmon	7	Image loaded (rule: ImageLoad)
Information	4/7/2022 6:21:22 PM	Sysmon	7	Image loaded (rule: ImageLoad)
Information	4/7/2022 6:21:22 PM	Sysmon	7	Image loaded (rule: ImageLoad)
Information	4/7/2022 6:21:22 PM	Sysmon	7	Image loaded (rule: ImageLoad)
Information	4/7/2022 6:21:22 PM	Sysmon	7	Image loaded (rule: ImageLoad)
Information	4/7/2022 6:21:21 PM	Sysmon	7	Image loaded (rule: ImageLoad)
Information	4/7/2022 6:21:21 PM	Sysmon	7	Image loaded (rule: ImageLoad)
Information	4/7/2022 6:21:21 PM	Sysmon	7	Image loaded (rule: ImageLoad)
Information	4/7/2022 6:21:21 PM	Sysmon	7	Image loaded (rule: ImageLoad)
Information	4/7/2022 6:21:21 PM	Sysmon	7	Image loaded (rule: ImageLoad)
Information	4/7/2022 6:21:21 PM	Sysmon	7	Image loaded (rule: ImageLoad)
Information	4/7/2022 6:21:21 PM	Sysmon	7	Image loaded (rule: ImageLoad)

Let's now see how a Sysmon event ID 7 looks like.

```
Image loaded:
RuleName: -
UtcTime: 2022-04-07 22:21:35.372
ProcessGuid: {2c4ac1bf-63dd-624f-640b-000000005d00}
ProcessId: 8060
Image: C:\Windows\System32\mmc.exe
ImageLoaded: C:\Windows\System32\psapi.dll
FileVersion: 10.0.18362.1 (WinBuild.160101.0800)
Description: Process Status Helper
Product: Microsoft® Windows® Operating System
Company: Microsoft Corporation
OriginalFileName: PSAPI
Hashes: MD5=89D92079F45D2F2539BCD1EEF73A701E,SHA256=6DAE0B5BAC5B2C34FD313B51AC793B6F0C270DA01474E4D1016B119FC1F9CE8F,IMPHASH=A19426362F5443C7159B76FBEAFD171F
Signed: true
Signature: Microsoft Windows
SignatureStatus: Valid
User: DESKTOP-N33HELB\Waldo
```

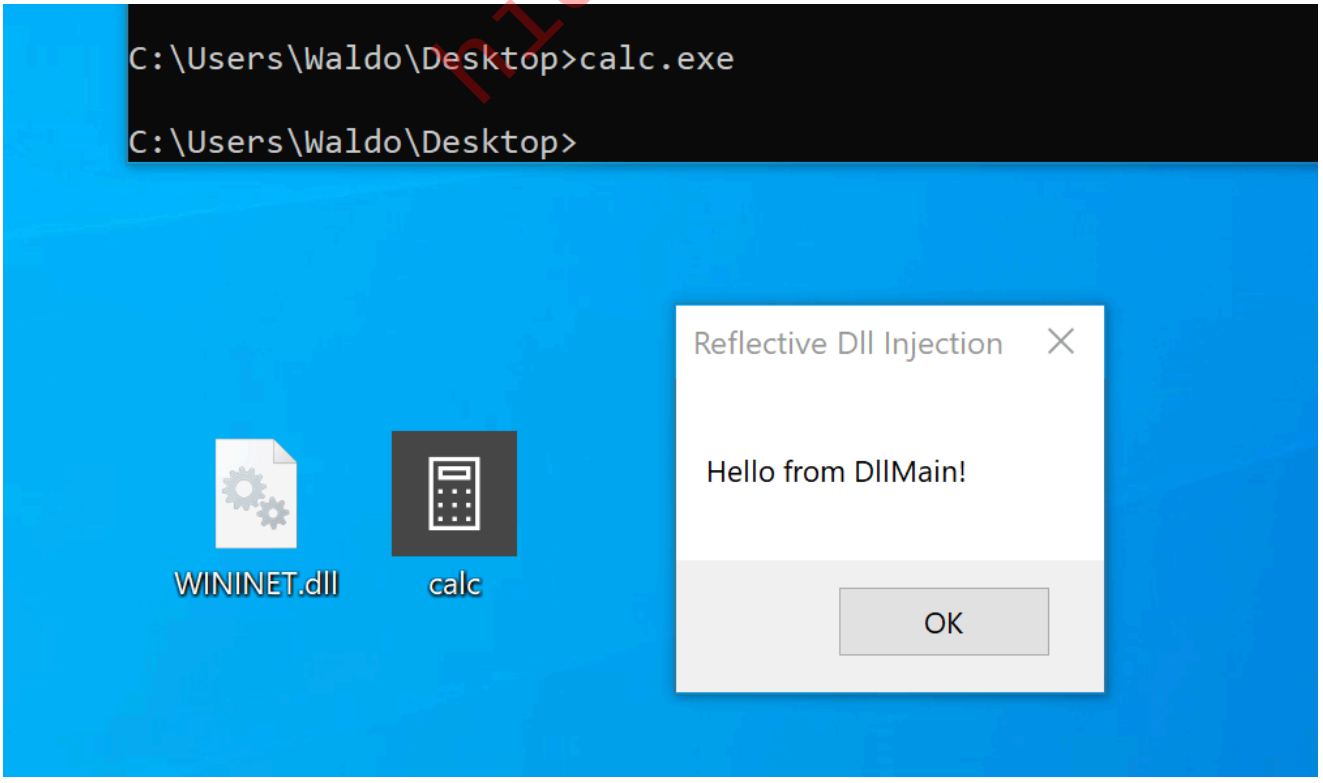

The event log contains the DLL's signing status (in this case, it is Microsoft-signed), the process or image responsible for loading the DLL, and the specific DLL that was loaded. In our example, we observe that "MMC.exe" loaded "psapi.dll", which is also Microsoft-signed. Both files are located in the System32 directory.

Now, let's proceed with building a detection mechanism. To gain more insights into DLL hijacks, conducting research is paramount. We stumble upon an informative blog post that provides an exhaustive list of various DLL hijack techniques. For the purpose of our detection, we will focus on a specific hijack involving the vulnerable executable calc.exe and a list of DLLs that can be hijacked.

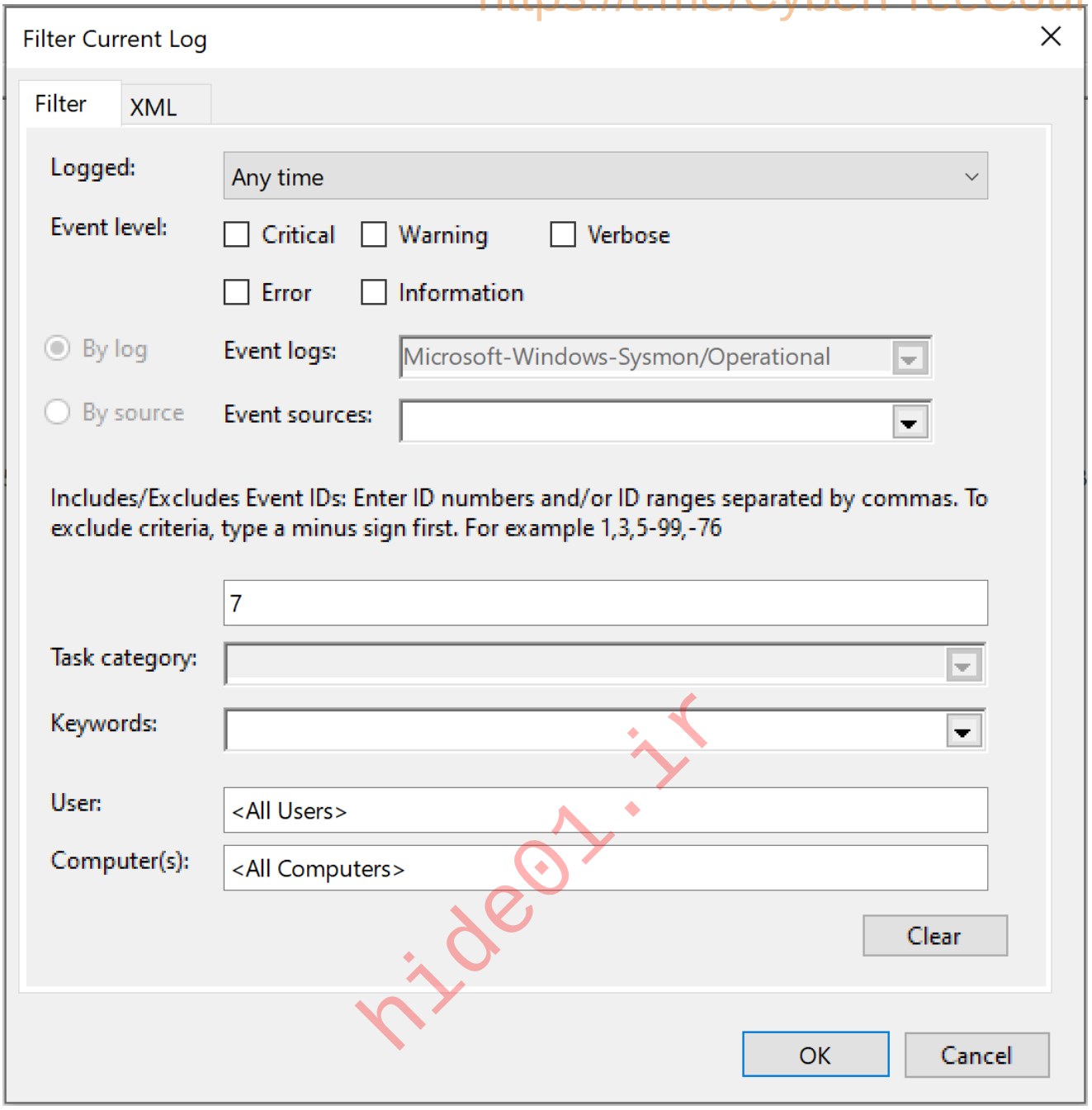
✗	calc.exe	CRYPTBASE.DLL	DllMain
✗		edputil.dll	DllMain
✗			EdpGetIsManaged
✗		MLANG.dll	ConvertINetUnicodeToMultiByte
✗			DllMain
✗		PROPSYS.dll	DllMain
✗			PSCreateMemoryPropertyStore
✗			PSPropertyBag_WriteDWORD
✗		Secur32.dll	DllMain
✗		SSPICLI.DLL	DllMain
✗			GetUserNameExW
✗		WININET.dll	DllMain
✗			GetUrlCacheEntryBinaryBlob

Let's attempt the hijack using "calc.exe" and "WININET.dll" as an example. To simplify the process, we can utilize Stephen Fewer's "hello world" reflective DLL. It should be noted that DLL hijacking does not require reflective DLLs.

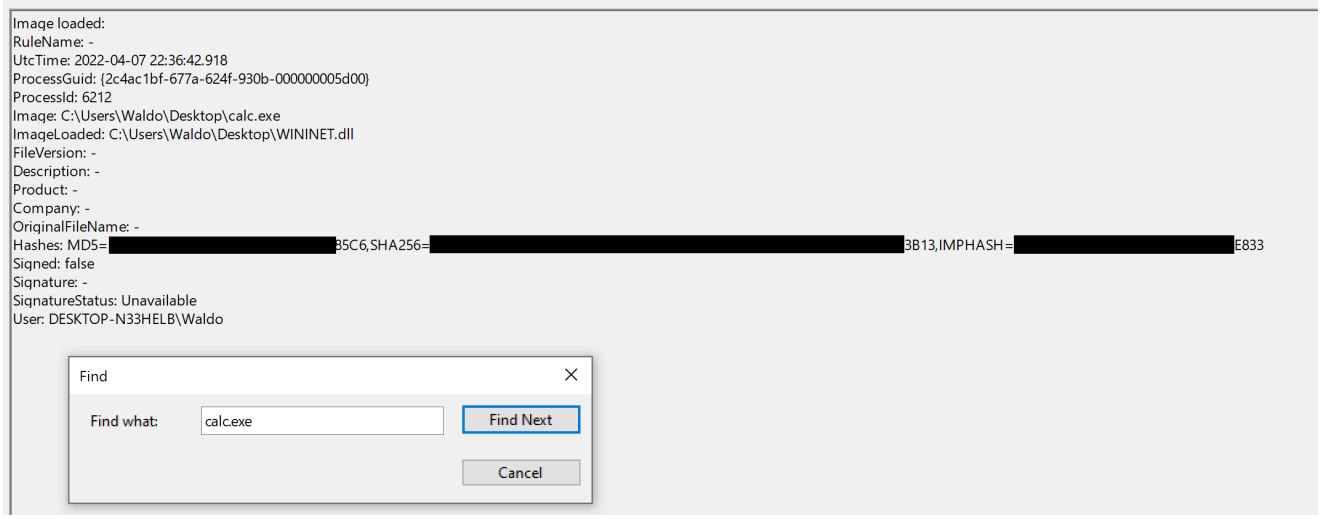
By following the required steps, which involve renaming `reflective_dll.x64.dll` to `WININET.dll`, moving `calc.exe` from `C:\Windows\System32` along with `WININET.dll` to a writable directory (such as the `Desktop` folder), and executing `calc.exe`, we achieve success. Instead of the Calculator application, a MessageBox is displayed.



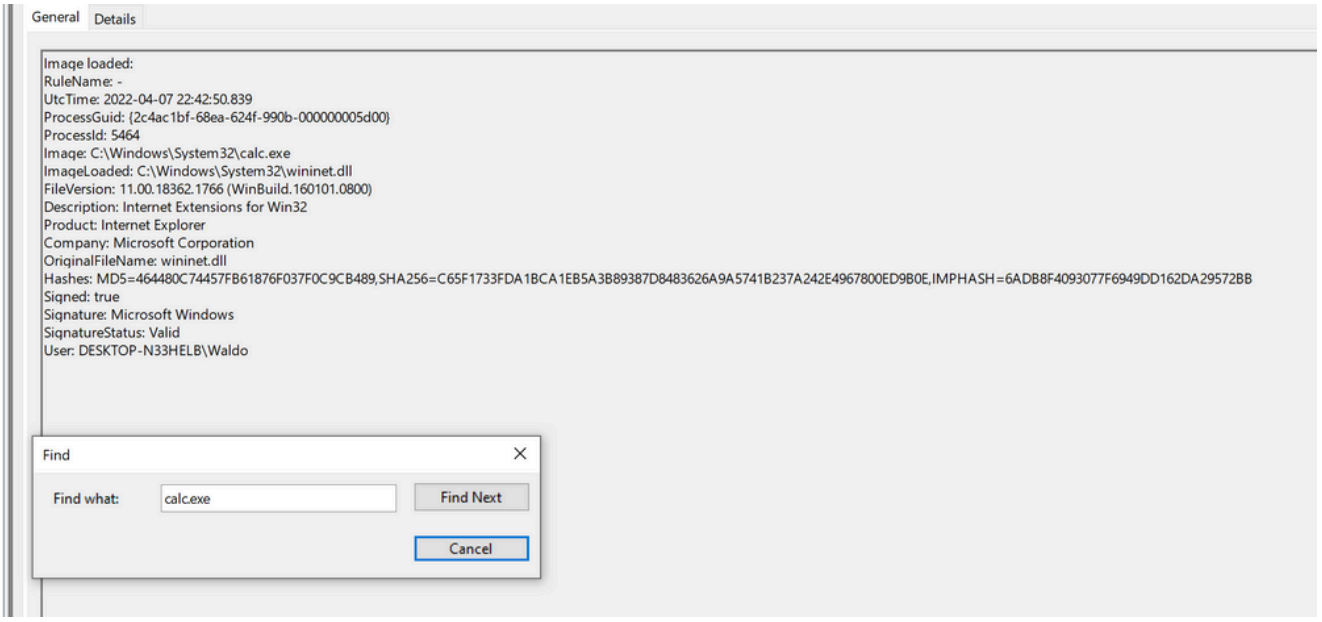
Next, we analyze the impact of the hijack. First, we filter the event logs to focus on `Event ID 7`, which represents module load events, by clicking "Filter Current Log...".



Subsequently, we search for instances of "calc.exe", by clicking "Find...", to identify the DLL load associated with our hijack.



The output from Sysmon provides valuable insights. Now, we can observe several indicators of compromise (IOCs) to create effective detection rules. Before moving forward though, let's compare this to an authenticate load of "wininet.dll" by "calc.exe".



Let's explore these IOCs:

1. "calc.exe", originally located in System32, should not be found in a writable directory. Therefore, a copy of "calc.exe" in a writable directory serves as an IOC, as it should always reside in System32 or potentially Syswow64.
2. "WININET.dll", originally located in System32, should not be loaded outside of System32 by calc.exe. If instances of "WININET.dll" loading occur outside of System32 with "calc.exe" as the parent process, it indicates a DLL hijack within calc.exe. While caution is necessary when alerting on all instances of "WININET.dll" loading outside of System32 (as some applications may package specific DLL versions for stability), in the case of "calc.exe", we can confidently assert a hijack due to the DLL's unchanging name, which attackers cannot modify to evade detection.
3. The original "WININET.dll" is Microsoft-signed, while our injected DLL remains unsigned.

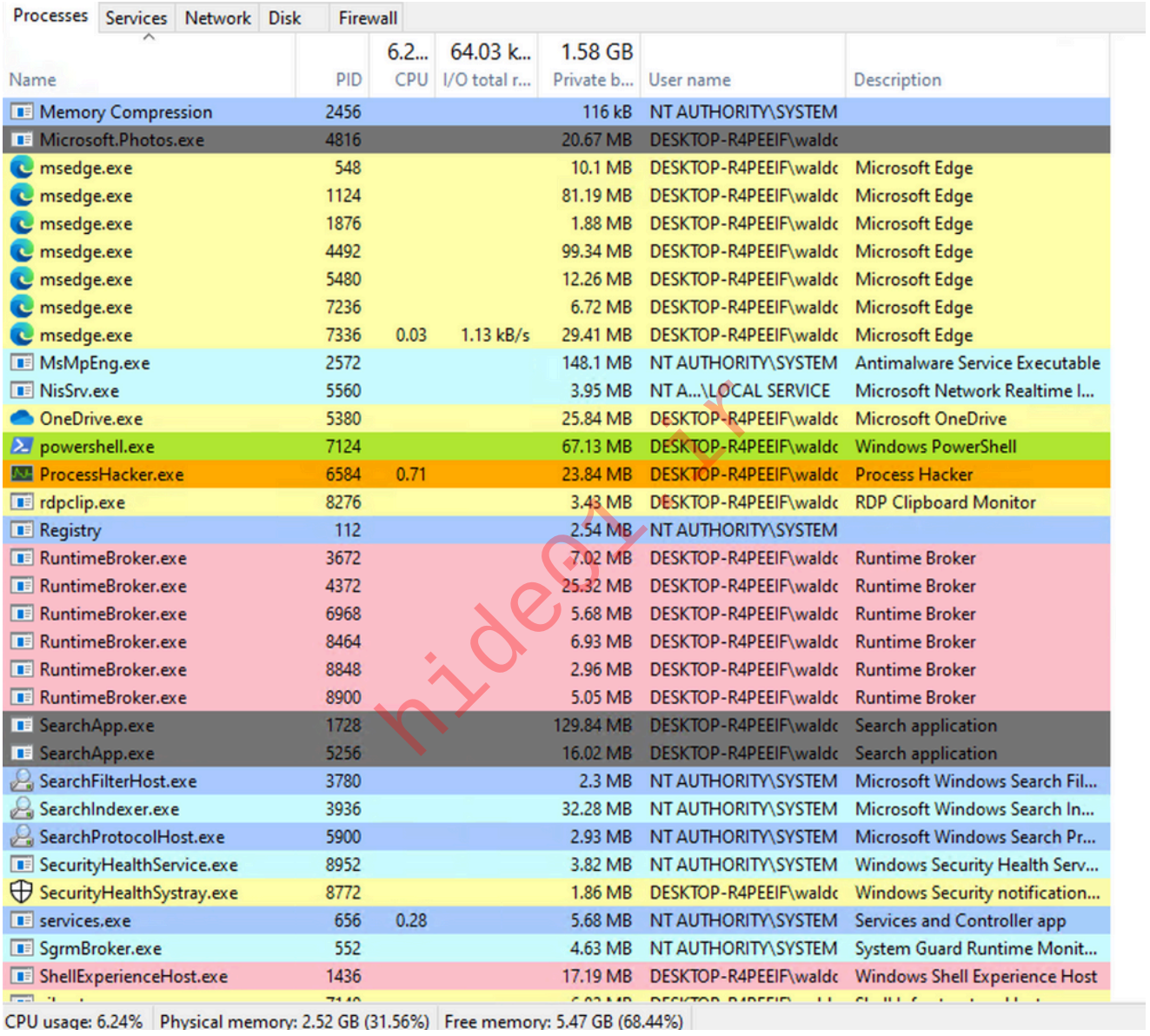
These three powerful IOCs provide an effective means of detecting a DLL hijack involving calc.exe. It's important to note that while Sysmon and event logs offer valuable telemetry for hunting and creating alert rules, they are not the sole sources of information.

Detection Example 2: Detecting Unmanaged PowerShell/C-Sharp Injection

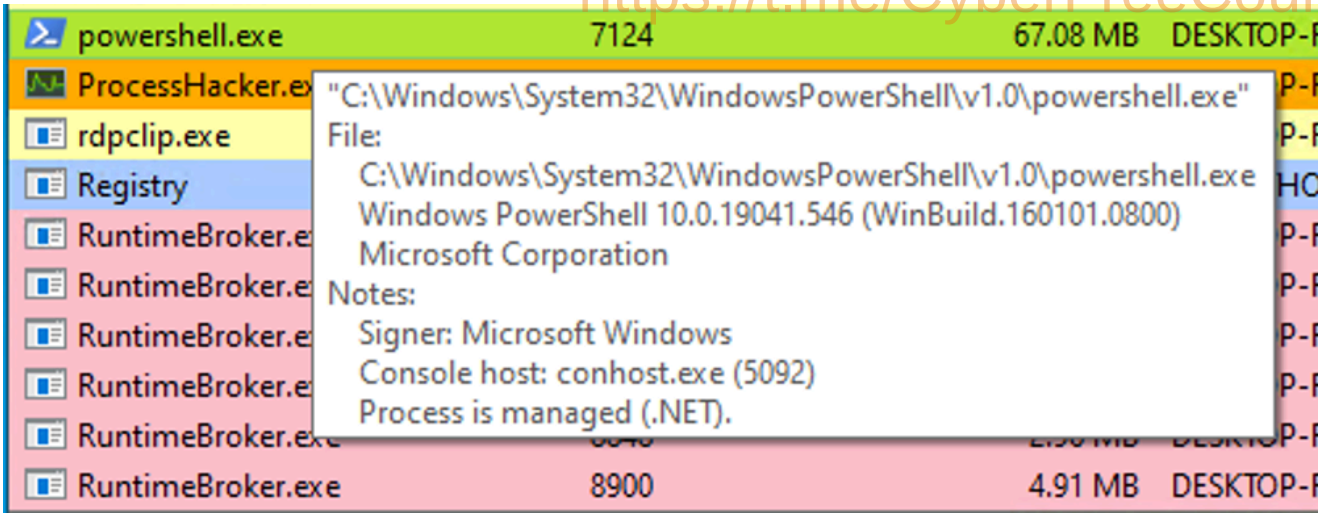
Before delving into detection techniques, let's gain a brief understanding of C# and its runtime environment. C# is considered a "managed" language, meaning it requires a

backend runtime to execute its code. The Common Language Runtime (CLR) serves as this runtime environment. Managed code does not directly run as assembly; instead, it is compiled into a bytecode format that the runtime processes and executes. Consequently, a managed process relies on the CLR to execute C# code.

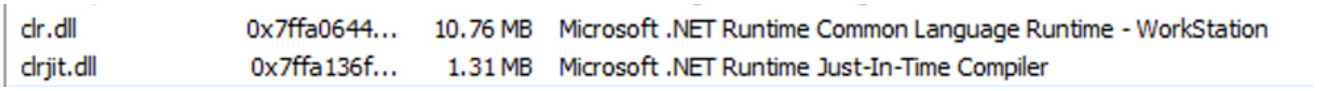
As defenders, we can leverage this knowledge to detect unusual C# injections or executions within our environment. To accomplish this, we can utilize a useful utility called Process Hacker.



By using Process Hacker, we can observe a range of processes within our environment. Sorting the processes by name, we can identify interesting color-coded distinctions. Notably, "powershell.exe", a managed process, is highlighted in green compared to other processes. Hovering over powershell.exe reveals the label "Process is managed (.NET)," confirming its managed status.



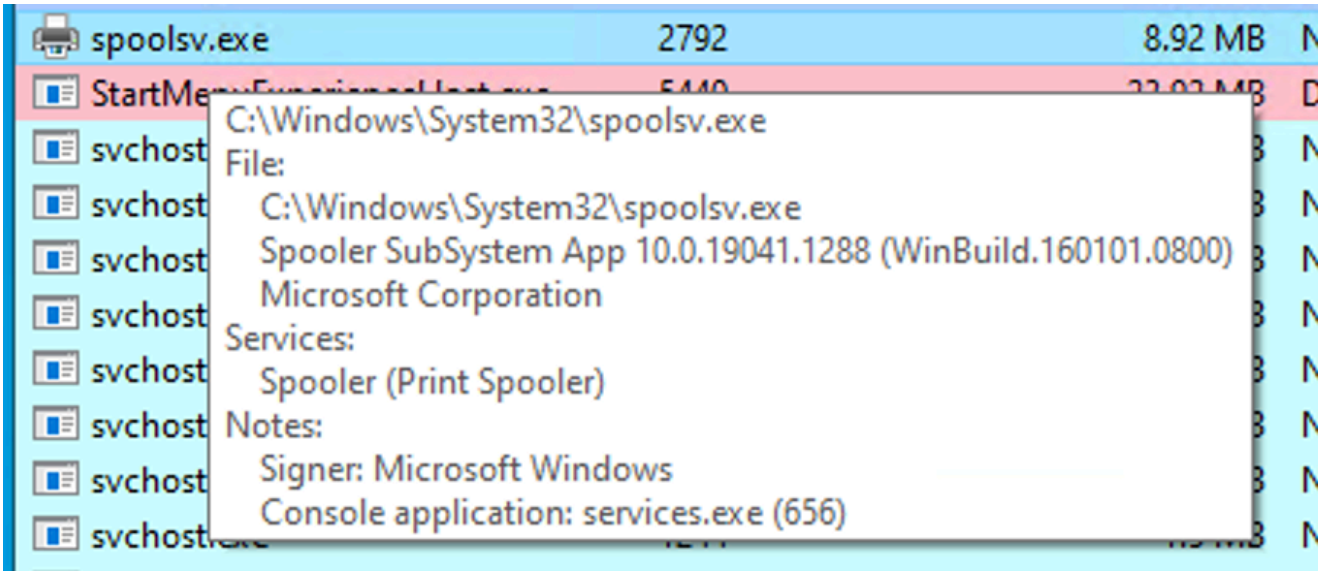
Examining the module loads for `powershell.exe`, by right-clicking on `powershell.exe`, clicking "Properties", and navigating to "Modules", we can find relevant information.



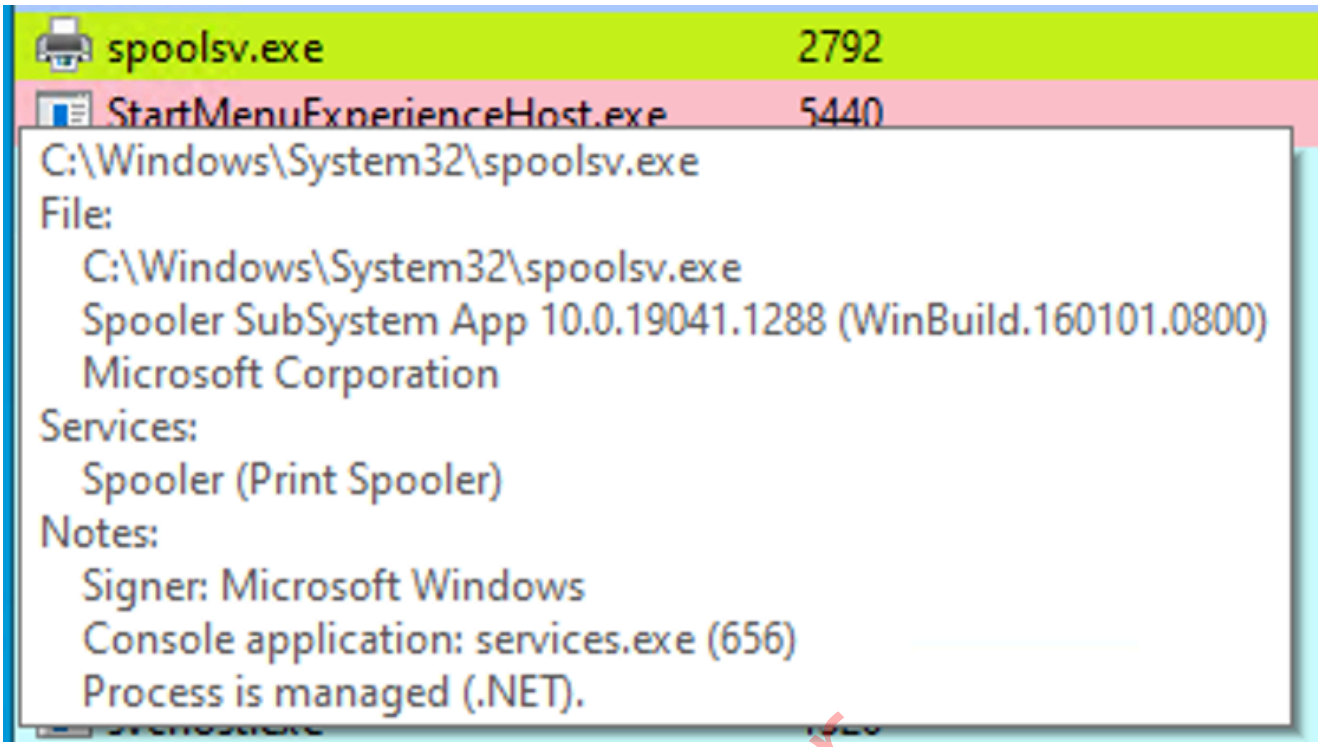
The presence of "Microsoft .NET Runtime...", `clr.dll`, and `clrjit.dll` should attract our attention. These 2 DLLs are used when C# code is ran as part of the runtime to execute the bytecode. If we observe these DLLs loaded in processes that typically do not require them, it suggests a potential execute-assembly or unmanaged PowerShell injection attack.

To showcase unmanaged PowerShell injection, we can inject an unmanaged PowerShell-like DLL into a random process, such as `spoolsv.exe`. We can do that by utilizing the PSInject project in the following manner.

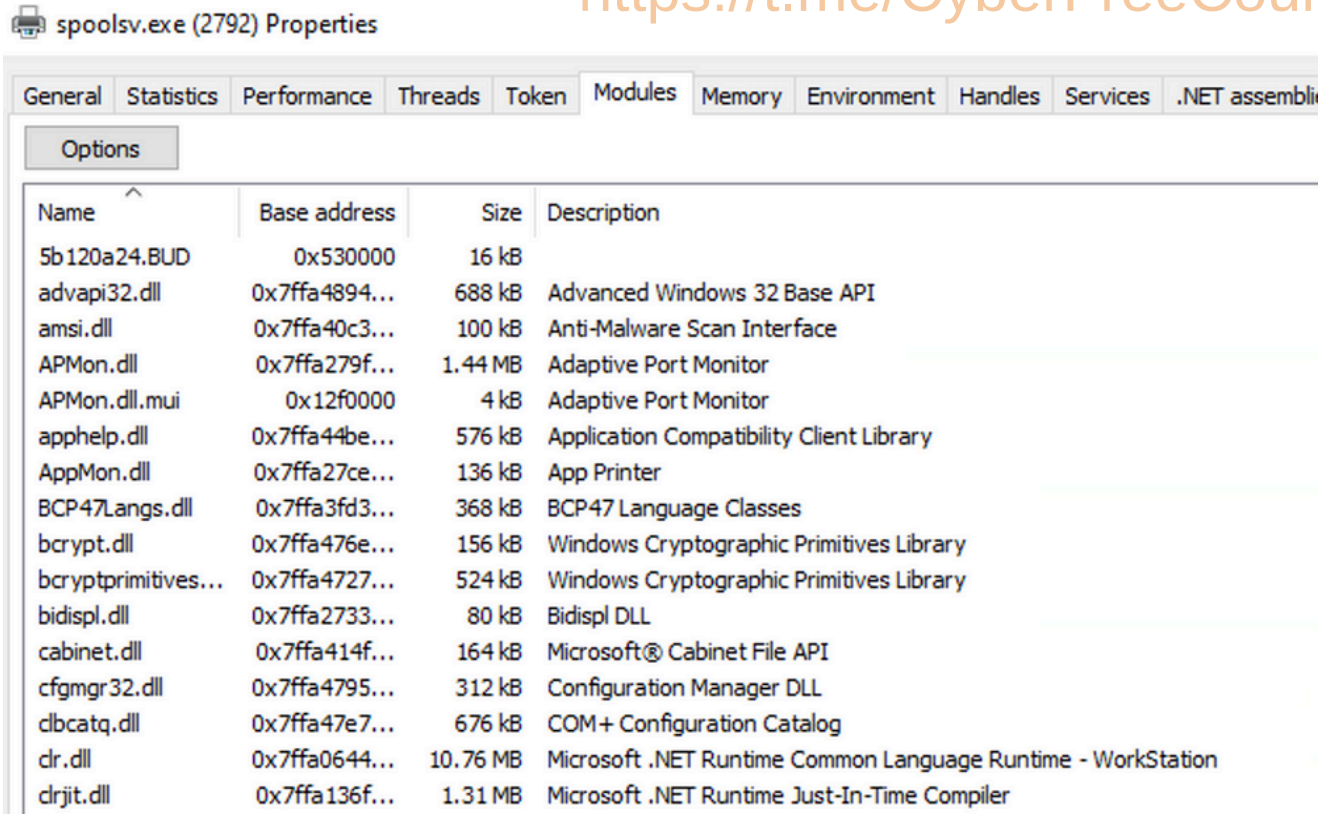
```
powershell -ep bypass
Import-Module .\Invoke-PSInject.ps1
Invoke-PSInject -ProcId [Process ID of spoolsv.exe] -PoshCode
"V3JpdGUtSG9zdCAiSGVsbG8sIEd1cnU5OSEi"
```

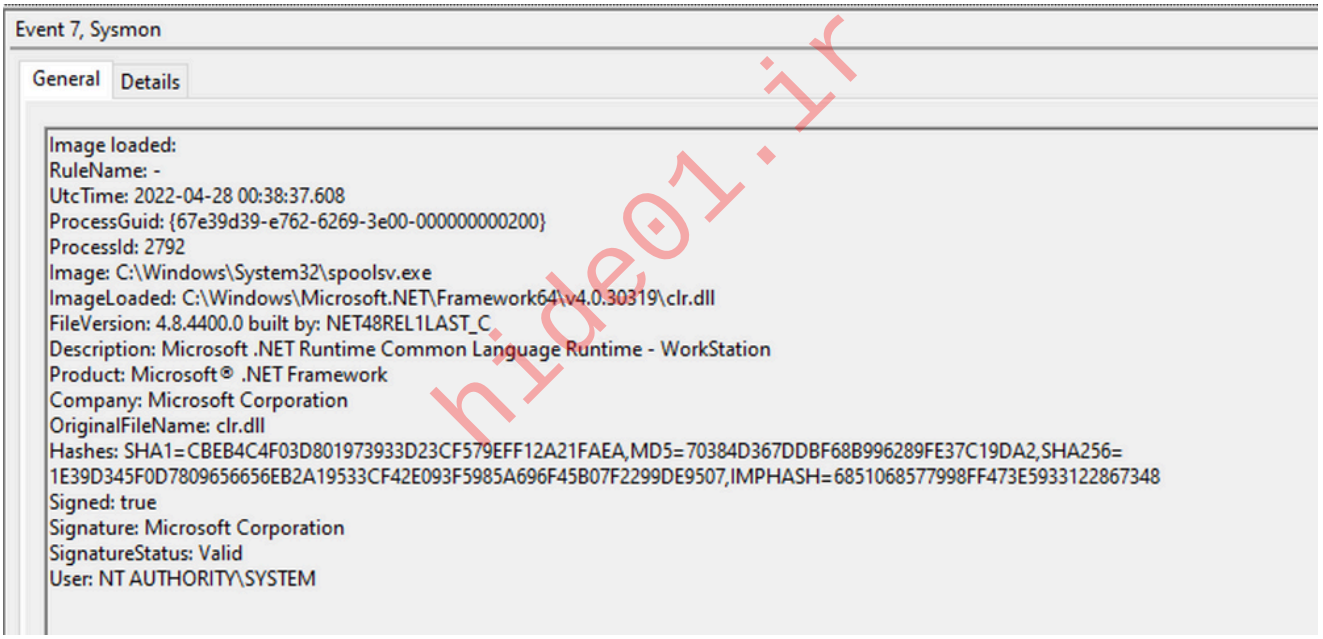


After the injection, we observe that "spoolsv.exe" transitions from an unmanaged to a managed state.



Additionally, by referring to both the related "Modules" tab of Process Hacker and Sysmon `Event ID 7`, we can examine the DLL load information to validate the presence of the aforementioned DLLs.





Detection Example 3: Detecting Credential Dumping

Another critical aspect of cybersecurity is detecting credential dumping activities. One widely used tool for credential dumping is Mimikatz, offering various methods for extracting Windows credentials. One specific command, "sekurlsa::logonpasswords", enables the dumping of password hashes or plaintext passwords by accessing the Local Security Authority Subsystem Service (LSASS). LSASS is responsible for managing user credentials and is a primary target for credential-dumping tools like Mimikatz.

The attack can be executed as follows.

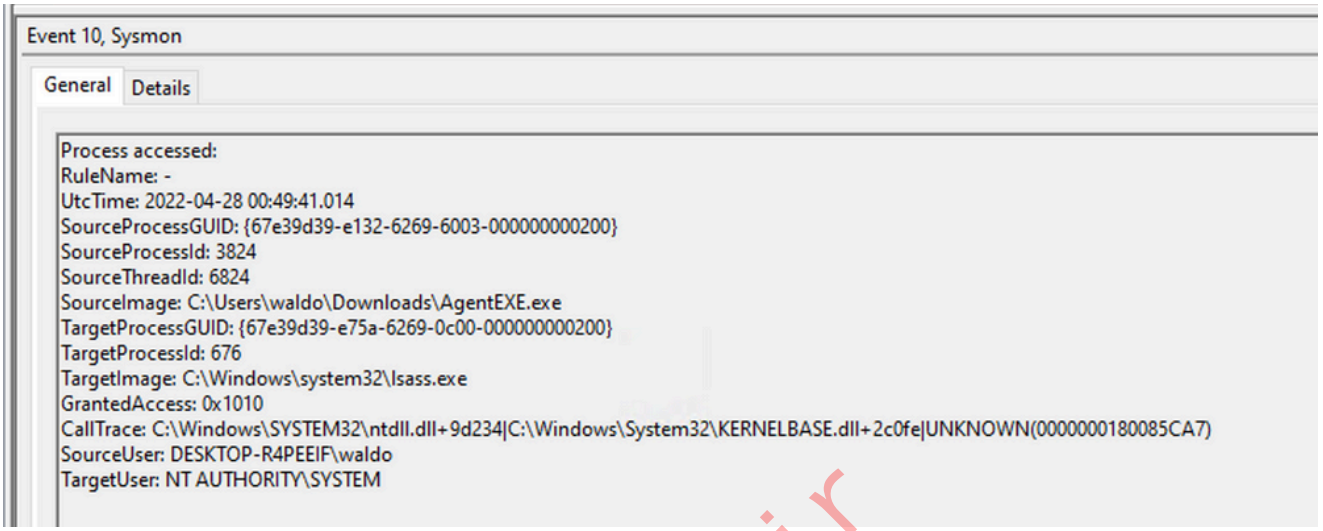
```
C:\Tools\Mimikatz> mimikatz.exe

  .#####.   mimikatz 2.2.0 (x64) #18362 Feb 29 2020 11:13:36
 .## ^ ##.  "A La Vie, A L'Amour" - (oe.eo)
 ## / \ ##  /*** Benjamin DELPY `gentilkiwi` ( [email protected] )
 ## \ / ##       > http://blog.gentilkiwi.com/mimikatz
 '## v ##'       Vincent LE TOUX             ( [email protected] )
  '#####'        > http://pingcastle.com / http://mysmartlogon.com   ***/

mimikatz # privilege::debug
Privilege '20' OK

mimikatz # sekurlsa::logonpasswords

Authentication Id : 0 ; 1128191 (00000000:001136ff)
Session           : RemoteInteractive from 2
User Name         : Administrator
Domain            : DESKTOP-NU10MTO
Logon Server      : DESKTOP-NU10MTO
Logon Time        : 5/31/2023 4:14:41 PM
SID               : S-1-5-21-2712802632-2324259492-1677155984-500
        msv :
         [00000003] Primary
         * Username : Administrator
         * Domain   : DESKTOP-NU10MTO
         * NTLM     : XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
         * SHA1     : XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX0812156b
        tspkg :
        wdigest :
         * Username : Administrator
         * Domain   : DESKTOP-NU10MTO
         * Password : (null)
        kerberos :
         * Username : Administrator
         * Domain   : DESKTOP-NU10MTO
         * Password : (null)
        ssp :   KO
        credman :
```


As we can see, the output of the "sekurlsa::logonpasswords" command provides powerful insights into compromised credentials.

To detect this activity, we can rely on a different Sysmon event. Instead of focusing on DLL loads, we shift our attention to process access events. By checking `Sysmon event ID 10`, which represents "ProcessAccess" events, we can identify any suspicious attempts to access LSASS.

Event ID 10: ProcessAccess

The process accessed event reports when a process opens another process, an operation that's often followed by information queries or reading and writing the address space of the target process. This enables detection of hacking tools that read the memory contents of processes like Local Security Authority (Lsass.exe) in order to steal credentials for use in Pass-the-Hash attacks. Enabling it can generate significant amounts of logging if there are diagnostic utilities active that repeatedly open processes to query their state, so it generally should only be done so with filters that remove expected accesses.



For instance, if we observe a random file ("AgentEXE" in this case) from a random folder ("Downloads" in this case) attempting to access LSASS, it indicates unusual behavior. Additionally, the `SourceUser` being different from the `TargetUser` (e.g., "waldo" as the `SourceUser` and "SYSTEM" as the `TargetUser`) further emphasizes the abnormality. It's also worth noting that as part of the mimikatz-based credential dumping process, the user must request SeDebugPrivileges. As the name suggests, it's primarily used for debugging. This can be another Indicator of Compromise (IOC).

Please note that some legitimate processes may access LSASS, such as authentication-related processes or security tools like AV or EDR.

Practical Exercises

Navigate to the bottom of this section and click on `Click here to spawn the target system!`

Then, RDP to `[Target IP]` using the provided credentials and answer the questions below. Do not forget to configure Sysmon accordingly, before you replicate the attacks.

```
xfreerdp /u:Administrator /p:'HTB_@cad3my_lab_W1n10_r00t!@0' /v:[Target IP] /dynamic-resolution
```

Event Tracing for Windows (ETW)

In the realm of effective threat detection and incident response, we often find ourselves relying on the limited log data at our disposal. However, this approach falls short of fully harnessing the immense wealth of information that can be derived from the powerful resource known as `Event Tracing for Windows (ETW)`. Unfortunately, this oversight can be attributed to a lack of awareness and appreciation for the comprehensive and intricate insights that ETW can offer.

What is ETW?

According to Microsoft, `Event Tracing For Windows (ETW)` is a general-purpose, high-speed tracing facility provided by the operating system. Using a buffering and logging mechanism implemented in the kernel, ETW provides a tracing mechanism for events raised by both user-mode applications and kernel-mode device drivers.

ETW, functioning as a high-performance event tracing mechanism deeply embedded within the Windows operating system, presents an unparalleled opportunity to bolster our defense capabilities. Its architecture facilitates the dynamic generation, collection, and analysis of various events occurring within the system, resulting in the creation of intricate, real-time logs that encompass a wide spectrum of activities.

By effectively leveraging ETW, we can tap into an expansive array of telemetry sources that surpass the limitations imposed by traditional log data. ETW captures a diverse set of events, spanning system calls, process creation and termination, network activity, file and registry modifications, and numerous other dimensions. These events collectively weave a detailed tapestry of system activity, furnishing invaluable context for the identification of anomalous behavior, discovery of potential security incidents, and facilitation of forensic investigations.

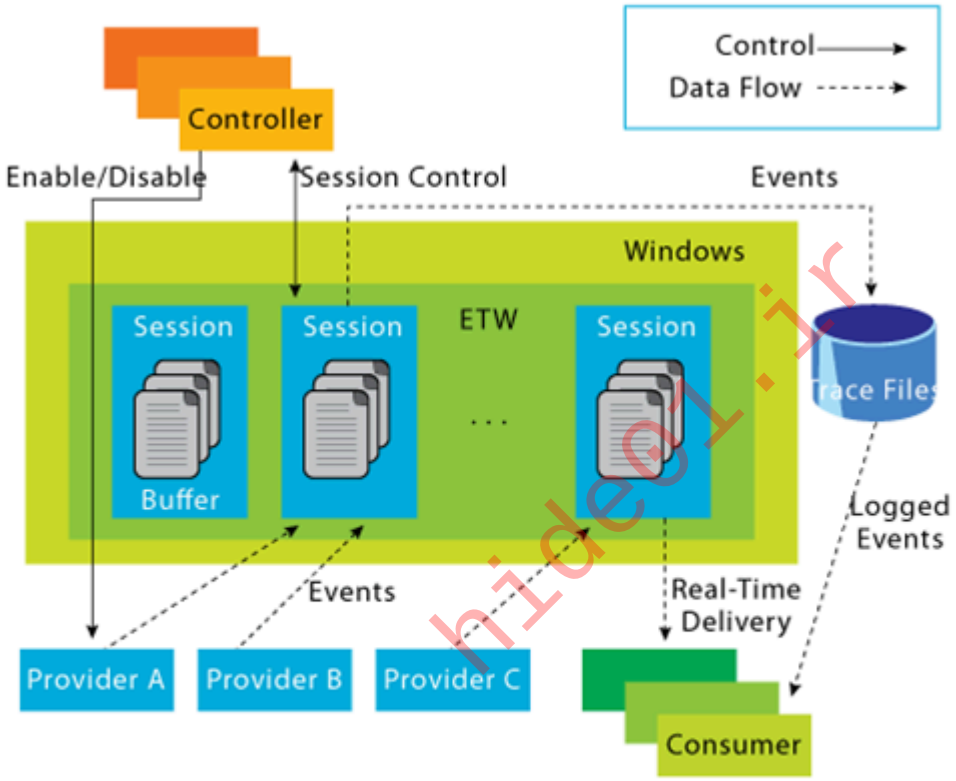
ETW's versatility and extensibility are further accentuated by its seamless integration with Event Providers. These specialized components generate specific types of events and can be seamlessly incorporated into applications, operating system components, or third-party software. Consequently, this integration ensures a broad coverage of potential event sources. Furthermore, ETW's extensibility enables the creation of custom providers tailored to address specific organizational requirements, thereby fostering a targeted and focused approach to logging and monitoring.

Notably, ETW's lightweight nature and minimal performance impact render it an optimal telemetry solution for real-time monitoring and continuous security assessment. By selectively enabling and configuring relevant event providers, we can finely adjust the scope of data collection to align with our specific security objectives, striking a harmonious balance between the richness of information and system performance considerations.

Moreover, the existence of robust tooling and utilities, including Microsoft's Message Analyzer and PowerShell's `Get-WinEvent` cmdlet, greatly simplifies the retrieval, parsing, and analysis of ETW logs. These tools offer advanced filtering capabilities, event correlation mechanisms, and real-time monitoring features, empowering members of the blue team to extract actionable insights from the vast pool of information captured by ETW.

ETW Architecture & Components

The underlying architecture and the key components of Event Tracing for Windows (ETW) are illustrated in the following diagram from Microsoft.



- `Controllers` : The Controllers component, as its name implies, assumes control over all aspects related to ETW operations. It encompasses functionalities such as initiating and terminating trace sessions, as well as enabling or disabling providers within a particular trace. Trace sessions can establish subscriptions to one or multiple providers, thereby granting the providers the ability to commence logging operations. An example of a widely used controller is the built-in utility "logman.exe," which facilitates the management of ETW activities.

At the core of ETW's architecture is the publish-subscribe model. This model involves two primary components:

- `Providers`: Providers play a pivotal role in generating events and writing them to the designated ETW sessions. Applications have the ability to register ETW providers, enabling them to generate and transmit numerous events. There are four distinct types of providers utilized within ETW.
  - `MOF Providers`: These providers are based on Managed Object Format (MOF) and are capable of generating events according to predefined MOF schemas. They offer a flexible approach to event generation and are widely used in various scenarios.
  - `WPP Providers`: Standing for "Windows Software Trace Preprocessor," WPP providers leverage specialized macros and annotations within the application's source code to generate events. This type of provider is often utilized for low-level kernel-mode tracing and debugging purposes.
  - `Manifest-based Providers`: Manifest-based providers represent a more contemporary form of providers within ETW. They rely on XML manifest files that define the structure and characteristics of events. This approach offers enhanced flexibility and ease of management, allowing for dynamic event generation and customization.
  - `TraceLogging Providers`: TraceLogging providers offer a simplified and efficient approach to event generation. They leverage the TraceLogging API, introduced in recent Windows versions, which streamlines the process of event generation with minimal code overhead.
- `Consumers`: Consumers subscribe to specific events of interest and receive those events for further processing or analysis. By default, the events are typically directed to an .ETL (Event Trace Log) file for handling. However, an alternative consumer scenario involves leveraging the capabilities of the Windows API to process and consume the events.
- `Channels`: To facilitate efficient event collection and consumption, ETW relies on event channels. Event channels act as logical containers for organizing and filtering events based on their characteristics and importance. ETW supports multiple channels, each with its own defined purpose and audience. Event consumers can selectively subscribe to specific channels to receive relevant events for their respective use cases.
- `ETL files`: ETW provides specialized support for writing events to disk through the use of event trace log files, commonly referred to as "ETL files." These files serve as durable storage for events, enabling offline analysis, long-term archiving, and forensic investigations. ETW allows for seamless rotation and management of ETL files to ensure efficient storage utilization.

Notes:

- ETW supports event providers in both kernel mode and user mode.
- Some event providers generate a significant volume of events, which can potentially overwhelm the system resources if they are constantly active. As a result, to prevent

unnecessary resource consumption, these providers are typically disabled by default and are only enabled when a tracing session specifically requests their activation.

- In addition to its inherent capabilities, ETW can be extended through custom event providers.
- Only ETW provider events that have a Channel property applied to them can be consumed by the event log

---

Interacting With ETW

`Logman` is a pre-installed utility for managing Event Tracing for Windows (ETW) and Event Tracing Sessions. This tool is invaluable for creating, initiating, halting, and investigating tracing sessions. This is particularly useful when determining which sessions are set for data collection or when initiating your own data collection.

Employing the `-ets` parameter will allow for a direct investigation of the event tracing sessions, providing insights into system-wide tracing sessions. As an example, the Sysmon Event Tracing Sessions can be found towards the end of the displayed information.


```
C:\Tools> logman.exe query -ets

Data Collector Set                      Type
Status
-------------------------------------------------------------------------------
-----
Circular Kernel Context Logger          Trace
Running
Eventlog-Security                       Trace
Running
DiagLog                                 Trace
Running
Diagtrack-Listener                      Trace
Running
EventLog-Application                    Trace
Running
EventLog-Microsoft-Windows-Sysmon-Operational Trace
Running
EventLog-System                         Trace
Running
LwtNetLog                               Trace
Running
Microsoft-Windows-Rdp-Graphics-RdpIdd-Trace Trace
Running
NetCore                                 Trace
Running
NtfsLog                                 Trace
```

```
Running
RadioMgr                                Trace
Running
UBPM                                    Trace
Running
WdiContextLog                           Trace
Running
WiFiSession                             Trace
Running
SHS-06012023-115154-7-7f                Trace
Running
UserNotPresentTraceSession              Trace
Running
8696EAC4-1288-4288-A4EE-49EE431B0AD9    Trace
Running
ScreenOnPowerStudyTraceSession          Trace
Running
SYSMON TRACE                            Trace
Running
MSDTC_TRACE_SESSION                     Trace
Running
SysmonDnsEtwSession                     Trace
Running
MpWppTracing-20230601-115025-00000003-ffffffff Trace
Running
WindowsUpdate_trace_log                 Trace
Running
Admin_PS_Provider                       Trace
Running
Terminal-Services-LSM-ApplicationLag-3764 Trace
Running
Microsoft.Windows.Remediation           Trace
Running
SgrmEtwSession                          Trace
Running

The command completed successfully.
```


When we examine an Event Tracing Session directly, we uncover specific session details including the Name, Max Log Size, Log Location, and the subscribed providers. This information is invaluable for incident responders. Discovering a session that records providers relevant to your interests may provide crucial logs for an investigation.

Please note that the “-ets” parameter is vital to the command. Without it, Logman will not identify the Event Tracing Session.

For each provider subscribed to the session, we can acquire critical data:

- `Name / Provider GUID`: This is the exclusive identifier for the provider.
- `Level`: This describes the event level, indicating if it's filtering for warning, informational, critical, or all events.
- `Keywords Any`: Keywords create a filter based on the kind of event generated by the provider.

```
C:\Tools> logman.exe query "EventLog-System" -ets

Name:                 EventLog-System
Status:               Running
Root Path:            %systemdrive%\PerfLogs\Admin
Segment:              Off
Schedules:            On
Segment Max Size:     100 MB

Name:                 EventLog-System\EventLog-System
Type:                 Trace
Append:               Off
Circular:             Off
Overwrite:            Off
Buffer Size:          64
Buffers Lost:         0
Buffers Written:      47
Buffer Flush Timer:   1
Clock Type:           System
File Mode:            Real-time

Provider:
Name:                 Microsoft-Windows-FunctionDiscoveryHost
Provider Guid:        {538CBBAD-4877-4EB2-B26E-7CAEE8F0F8CB}
Level:                255
KeywordsAll:          0x0
KeywordsAny:          0x8000000000000000 (System)
Properties:           65
Filter Type:          0

Provider:
Name:                 Microsoft-Windows-Subsys-SMSS
Provider Guid:        {43E63DA5-41D1-4FBF-ADED-1BBED98FDD1D}
Level:                255
KeywordsAll:          0x0
KeywordsAny:          0x4000000000000000 (System)
Properties:           65
Filter Type:          0

Provider:
Name:                 Microsoft-Windows-Kernel-General
Provider Guid:        {A68CA8B7-004F-D7B6-A698-07E2DE0F1F5D}
```

```
Level:                 255
KeywordsAll:           0x0
KeywordsAny:           0x8000000000000000 (System)
Properties:            65
Filter Type:           0

Provider:
Name:                  Microsoft-Windows-FilterManager
Provider Guid:         {F3C5E28E-63F6-49C7-A204-E48A1BC4B09D}
Level:                 255
KeywordsAll:           0x0
KeywordsAny:           0x8000000000000000 (System)
Properties:            65
Filter Type:           0

--- SNIP ---

The command completed successfully.
```

By using the `logman query providers` command, we can generate a list of all available providers on the system, including their respective GUIDs.


```
C:\Tools> logman.exe query providers

Provider                                GUID
-------------------------------------------------------------------------------
ACPI Driver Trace Provider              {DAB01D4D-2D48-477D-B1C3-
DAAD0CE6F06B}
Active Directory Domain Services: SAM   {8E598056-8993-11D2-819E-
0000F875A064}
Active Directory: Kerberos Client       {BBA3ADD2-C229-4CDB-AE2B-
57EB6966B0C4}
Active Directory: NetLogon              {F33959B4-DBEC-11D2-895B-
00C04F79AB69}
ADODB.1                                 {04C8A86F-3369-12F8-4769-
24E484A9E725}
ADOMD.1                                 {7EA56435-3F2F-3F63-A829-
F0B35B5CAD41}
Application Popup                       {47BFA2B7-BD54-4FAC-B70B-
29021084CA8F}
Application-Addon-Event-Provider        {A83FA99F-C356-4DED-9FD6-
5A5EB8546D68}
ATA Port Driver Tracing Provider        {D08BD885-501E-489A-BAC6-
B7D24BFE6BBF}
AuthFw NetShell Plugin                  {935F4AE6-845D-41C6-97FA-
380DAD429B72}
BCP.1                                   {24722B88-DF97-4FF6-E395-
```

```
DB533AC42A1E}
BFE Trace Provider                          {106B464A-8043-46B1-8CB8-
E92A0CD7A560}
BITS Service Trace                          {4A8AAA94-CFC4-46A7-8E4E-
17BC45608F0A}
Certificate Services Client CredentialRoaming Trace {EF4109DC-68FC-45AF-
B329-CA2825437209}
Certificate Services Client Trace           {F01B7774-7ED7-401E-8088-
B576793D7841}
Circular Kernel Session Provider            {54DEA73A-ED1F-42A4-AF71-
3E63D056F174}
Classpnp Driver Tracing Provider            {FA8DE7C4-ACDE-4443-9994-
C4E2359A9EDB}
Critical Section Trace Provider             {3AC66736-CC59-4CFF-8115-
8DF50E39816B}
DBNETLIB.1                                  {BD568F20-FCCD-B948-054E-
DB3421115D61}
Deduplication Tracing Provider              {5EBB59D1-4739-4E45-872D-
B8703956D84B}
Disk Class Driver Tracing Provider          {945186BF-3DD6-4F3F-9C8E-
9EDD3FC9D558}
Downlevel IPsec API                         {94335EB3-79EA-44D5-8EA9-
306F49B3A041}
Downlevel IPsec NetShell Plugin             {E4FF10D8-8A88-4FC6-82C8-
8C23E9462FE5}
Downlevel IPsec Policy Store                {94335EB3-79EA-44D5-8EA9-
306F49B3A070}
Downlevel IPsec Service                     {94335EB3-79EA-44D5-8EA9-
306F49B3A040}
EA IME API                                  {E2A24A32-00DC-4025-9689-
C108C01991C5}
Error Instrument                            {CD7CF0D0-02CC-4872-9B65-
0DBA0A90EFE8}
FD Core Trace                               {480217A9-F824-4BD4-BBE8-
F371CAAF9A0D}
FD Publication Trace                        {649E3596-2620-4D58-A01F-
17AEFE8185DB}
FD SSDP Trace                               {DB1D0418-105A-4C77-9A25-
8F96A19716A4}
FD WNet Trace                               {8B20D3E4-581F-4A27-8109-
DF01643A7A93}
FD WSDAPI Trace                             {7E2DBFC7-41E8-4987-BCA7-
76CADFAD765F}
FDPHost Service Trace                       {F1C521CA-DA82-4D79-9EE4-
D7A375723B68}
File Kernel Trace; Operation Set 1          {D75D8303-6C21-4BDE-9C98-
ECC6320F9291}
File Kernel Trace; Operation Set 2          {058DD951-7604-414D-A5D6-
A56D35367A46}
File Kernel Trace; Optional Data            {7DA1385C-F8F5-414D-B9D0-
```

```
02FCA090F1EC}
File Kernel Trace; Volume To Log          {127D46AF-4AD3-489F-9165-
F00BA64D5467}
FWPKCLNT Trace Provider                   {AD33FA19-F2D2-46D1-8F4C-
E3C3087E45AD}
FWPUCLNT Trace Provider                   {5A1600D2-68E5-4DE7-BCF4-
1C2D215FE0FE}
Heap Trace Provider                       {222962AB-6180-4B88-A825-
346B75F2A24A}
IKEEXT Trace Provider                     {106B464D-8043-46B1-8CB8-
E92A0CD7A560}
IMAPI1 Shim                               {1FF10429-99AE-45BB-8A67-
C9E945B9FB6C}
IMAPI2 Concatenate Stream                 {0E85A5A5-4D5C-44B7-8BDA-
5B7AB54F7E9D}
IMAPI2 Disc Master                        {0E85A5A5-4D5C-44B7-8BDA-
5B7AB54F7E91}
IMAPI2 Disc Recorder                      {0E85A5A5-4D5C-44B7-8BDA-
5B7AB54F7E93}
IMAPI2 Disc Recorder Enumerator           {0E85A5A5-4D5C-44B7-8BDA-
5B7AB54F7E92}
IMAPI2 dll                                {0E85A5A5-4D5C-44B7-8BDA-
5B7AB54F7E90}
IMAPI2 Interleave Stream                  {0E85A5A5-4D5C-44B7-8BDA-
5B7AB54F7E9E}
IMAPI2 Media Eraser                       {0E85A5A5-4D5C-44B7-8BDA-
5B7AB54F7E97}
IMAPI2 MSF                                {0E85A5A5-4D5C-44B7-8BDA-
5B7AB54F7E9F}
IMAPI2 Multisession Sequential            {0E85A5A5-4D5C-44B7-8BDA-
5B7AB54F7EA0}
IMAPI2 Pseudo-Random Stream               {0E85A5A5-4D5C-44B7-8BDA-
5B7AB54F7E9C}
IMAPI2 Raw CD Writer                      {0E85A5A5-4D5C-44B7-8BDA-
5B7AB54F7E9A}
IMAPI2 Raw Image Writer                   {07E397EC-C240-4ED7-8A2A-
B9FF0FE5D581}
IMAPI2 Standard Data Writer               {0E85A5A5-4D5C-44B7-8BDA-
5B7AB54F7E98}
IMAPI2 Track-at-Once CD Writer            {0E85A5A5-4D5C-44B7-8BDA-
5B7AB54F7E99}
IMAPI2 Utilities                          {0E85A5A5-4D5C-44B7-8BDA-
5B7AB54F7E94}
IMAPI2 Write Engine                       {0E85A5A5-4D5C-44B7-8BDA-
5B7AB54F7E96}
IMAPI2 Zero Stream                        {0E85A5A5-4D5C-44B7-8BDA-
5B7AB54F7E9B}
IMAPI2FS Tracing                          {F8036571-42D9-480A-BABB-
DE7833CB059C}
Intel-iaLPSS-GPIO                         {D386CC7A-620A-41C1-ABF5-
```

```
55018C6C699A}
Intel-iaLPSS-I2C                          {D4AEAC44-AD44-456E-9C90-
33F8CDCED6AF}
Intel-iaLPSS2-GPIO2                       {63848CFF-3EC7-4DDF-8072-
5F95E8C8EB98}
Intel-iaLPSS2-I2C                         {C2F86198-03CA-4771-8D4C-
CE6E15CBCA56}
IPMI Driver Trace                         {D5C6A3E9-FA9C-434E-9653-
165B4FC869E4}
IPMI Provider Trace                       {651D672B-E11F-41B7-ADD3-
C2F6A4023672}
KMDFv1 Trace Provider                     {544D4C9D-942C-46D5-BF50-
DF5CD9524A50}
Layer2 Security HC Diagnostics Trace      {2E8D9EC5-A712-48C4-8CE0-
631EB0C1CD65}
Local Security Authority (LSA)            {CC85922F-DB41-11D2-9244-
006008269001}
LsaSrv                                    {199FE037-2B82-40A9-82AC-
E1D46C792B99}
Microsoft-Antimalware-AMFilter            {CFEB0608-330E-4410-B00D-
56D8DA9986E6}
Microsoft-Antimalware-Engine              {0A002690-3839-4E3A-B3B6-
96D8DF868D99}
Microsoft-Antimalware-Engine-Instrumentation {68621C25-DF8D-4A6B-AABC-
19A22E296A7C}
Microsoft-Antimalware-NIS                 {102AAB0A-9D9C-4887-A860-
55DE33B96595}
Microsoft-Antimalware-Protection          {E4B70372-261F-4C54-8FA6-
A5A7914D73DA}
Microsoft-Antimalware-RTP                 {8E92DEEF-5E17-413B-B927-
59B2F06A3CFC}
Microsoft-Antimalware-Scan-Interface      {2A576B87-09A7-520E-C21A-
4942F0271D67}
Microsoft-Antimalware-Service             {751EF305-6C6E-4FED-B847-
02EF79D26AEF}
Microsoft-Antimalware-ShieldProvider      {928F7D29-0577-5BE5-3BD3-
B6BDAB9AB307}
Microsoft-Antimalware-UacScan             {D37E7910-79C8-57C4-DA77-
52BB646364CD}
Microsoft-AppV-Client                     {E4F68870-5AE8-4E5B-9CE7-
CA9ED75B0245}
Microsoft-AppV-Client-StreamingUX         {28CB46C7-4003-4E50-8BD9-
442086762D12}
Microsoft-AppV-ServiceLog                 {9CC69D1C-7917-4ACD-8066-
6BF8B63E551B}
Microsoft-AppV-SharedPerformance          {FB4A19EE-EB5A-47A4-BC52-
E71AAC6D0859}
Microsoft-Client-Licensing-Platform       {B6CC0D55-9ECC-49A8-B929-
2B9022426F2A}
Microsoft-Gaming-Services                 {BC1BDB57-71A2-581A-147B-
```

```
E0B49474A2D4}
Microsoft-IE                                {9E3B3947-CA5D-4614-91A2-
7B624E0E7244}
Microsoft-IE-JSDumpHeap                     {7F8E35CA-68E8-41B9-86FE-
D6ADC5B327E7}
Microsoft-IEFRAME                           {5C8BB950-959E-4309-8908-
67961A1205D5}
Microsoft-JScript                           {57277741-3638-4A4B-BDBA-
0AC6E45DA56C}
Microsoft-OneCore-OnlineSetup               {41862974-DA3B-4F0B-97D5-
BB29FBB9B71E}
Microsoft-PerfTrack-IEFRAME                 {B2A40F1F-A05A-4DFD-886A-
4C4F18C4334C}
Microsoft-PerfTrack-MSHTML                  {FFDB9886-80F3-4540-AA8B-
B85192217DDF}
Microsoft-User Experience Virtualization-Admin {61BC445E-7A8D-420E-AB36-
9C7143881B98}
Microsoft-User Experience Virtualization-Agent Driver {DE29CF61-5EE6-43FF-
9AAC-959C4E13CC6C}
Microsoft-User Experience Virtualization-App Agent {1ED6976A-4171-4764-
B415-7EA08BC46C51}
Microsoft-User Experience Virtualization-IPC {21D79DB0-8E03-41CD-9589-
F3EF7001A92A}
Microsoft-User Experience Virtualization-SQM Uploader {57003E21-269B-4BDC-
8434-B3BF8D57D2D5}
Microsoft-Windows Networking VPN Plugin Platform {E5FC4A0F-7198-492F-9B0F-
88FDCBFDED48}
Microsoft-Windows-AAD                       {4DE9BC9C-B27A-43C9-8994-
0915F1A5E24F}
Microsoft-Windows-ACL-UI                    {EA4CC8B8-A150-47A3-AFB9-
C8D194B19452}

The command completed successfully.
```


Windows 10 includes more than 1,000 built-in providers. Moreover, Third-Party Software often incorporates its own ETW providers, especially those operating in Kernel mode.

Due to the high number of providers, it's usually advantageous to filter them using `findstr`. For instance, you will see multiple results for "Winlogon" in the given example.

```
C:\Tools> logman.exe query providers | findstr "Winlogon"
Microsoft-Windows-Winlogon                  {DBE9B383-7CF3-4331-91CC-
A3CB16A3B538}
Windows Winlogon Trace                      {D451642C-63A6-11D7-9720-
00B0D03E0347}
```

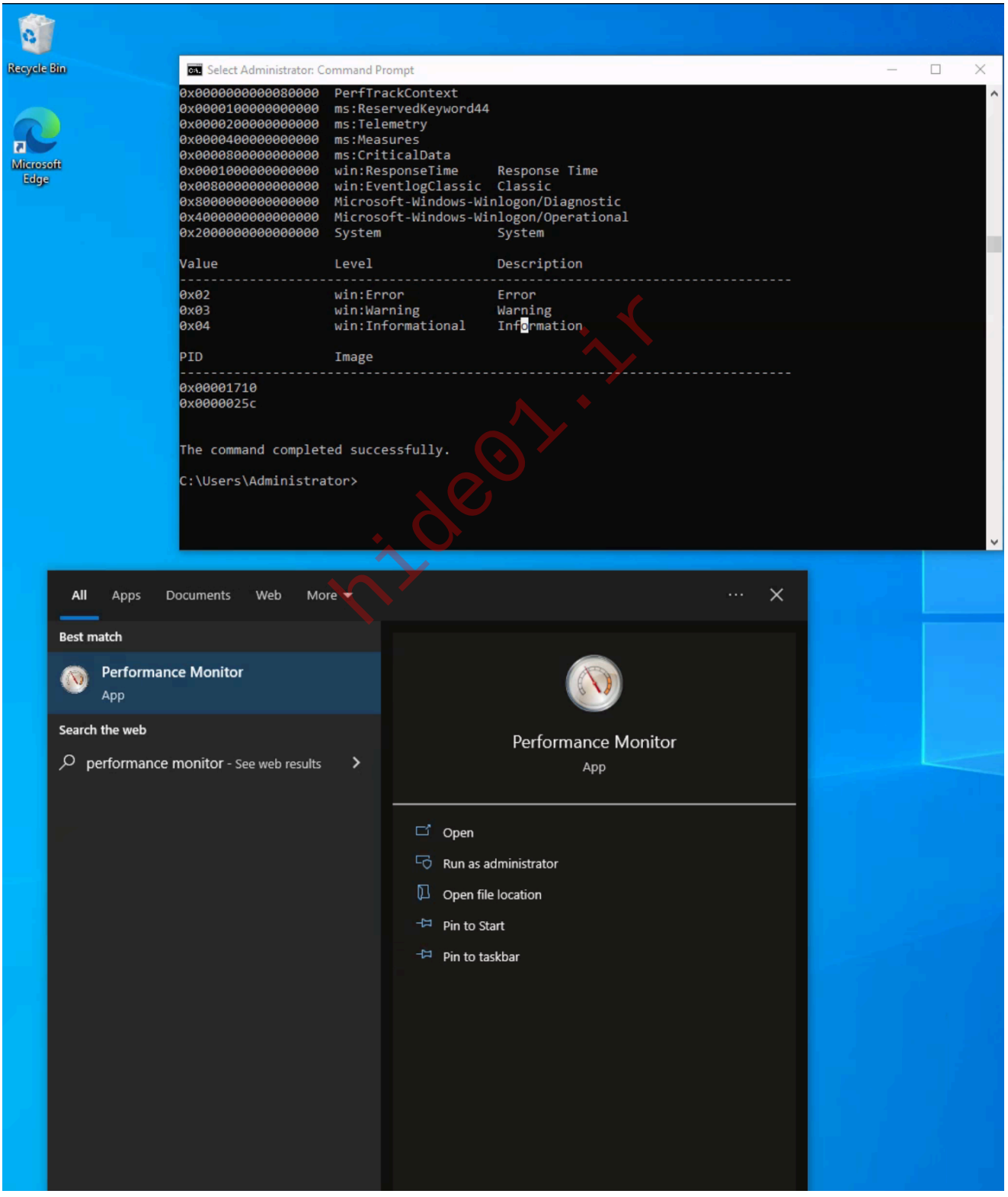
By specifying a provider with Logman, we gain a deeper understanding of the provider's function. This will inform us about the Keywords we can filter on, the available event levels, and which processes are currently utilizing the provider.

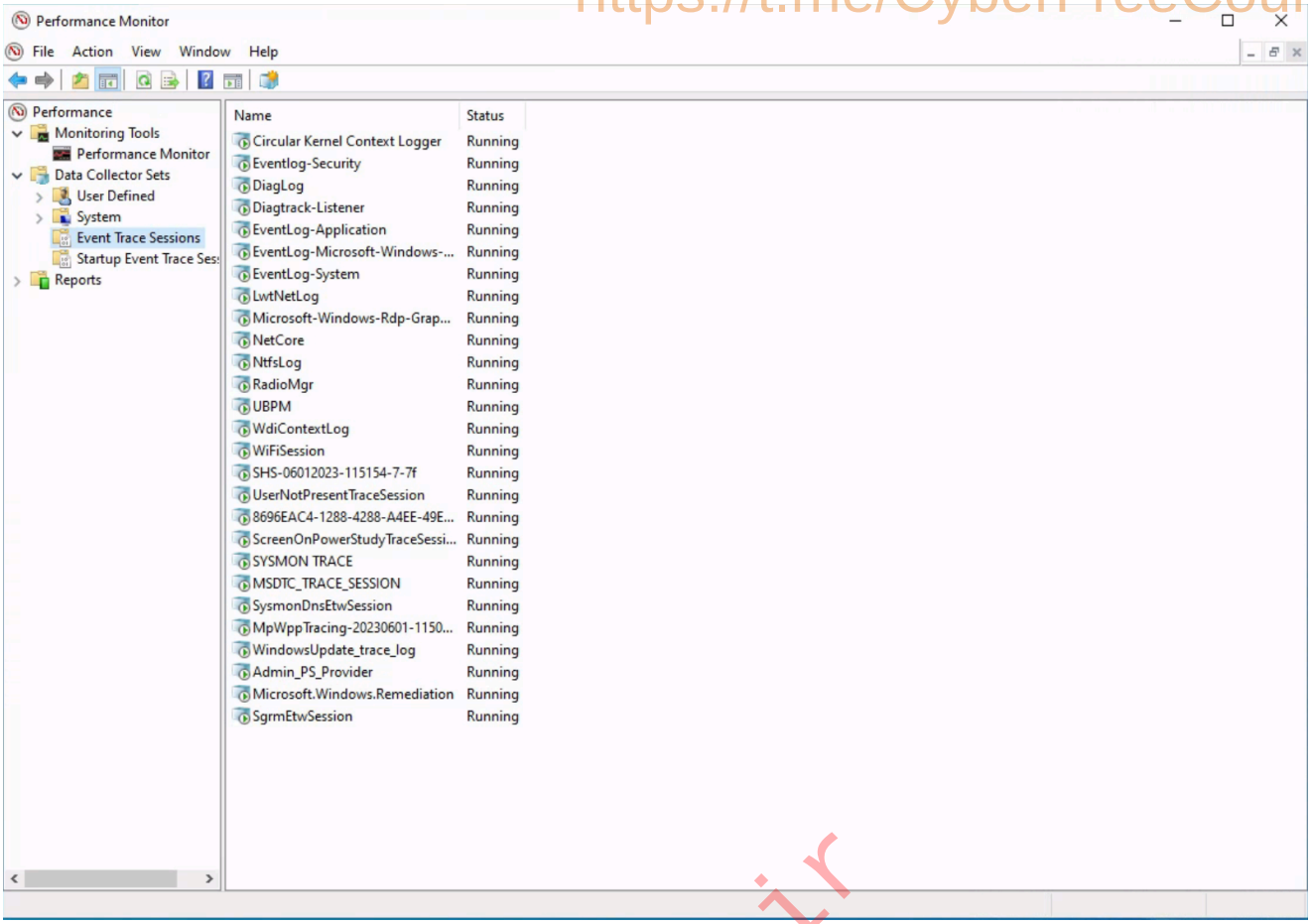
```
C:\Tools> logman.exe query providers Microsoft-Windows-Winlogon

Provider                                   GUID
-------------------------------------------------------------------------------
Microsoft-Windows-Winlogon                 {DBE9B383-7CF3-4331-91CC-
A3CB16A3B538}

Value               Keyword              Description
-------------------------------------------------------------------------------
0x0000000000010000  PerfInstrumentation
0x0000000000020000  PerfDiagnostics
0x0000000000040000  NotificationEvents
0x0000000000080000  PerfTrackContext
0x0000100000000000  ms:ReservedKeyword44
0x0000200000000000  ms:Telemetry
0x0000400000000000  ms:Measures
0x0000800000000000  ms:CriticalData
0x0001000000000000  win:ResponseTime     Response Time
0x0080000000000000  win:EventlogClassic  Classic
0x8000000000000000  Microsoft-Windows-Winlogon/Diagnostic
0x4000000000000000  Microsoft-Windows-Winlogon/Operational
0x2000000000000000  System               System

Value               Level                Description
-------------------------------------------------------------------------------
0x02                win:Error            Error
0x03                win:Warning          Warning
0x04                win:Informational    Information

PID                 Image
-------------------------------------------------------------------------------
0x00001710
0x0000025c

The command completed successfully.
```


The `Microsoft-Windows-Winlogon/Diagnostic` and `Microsoft-Windows-Winlogon/Operational` keywords reference the event logs generated from this provider.

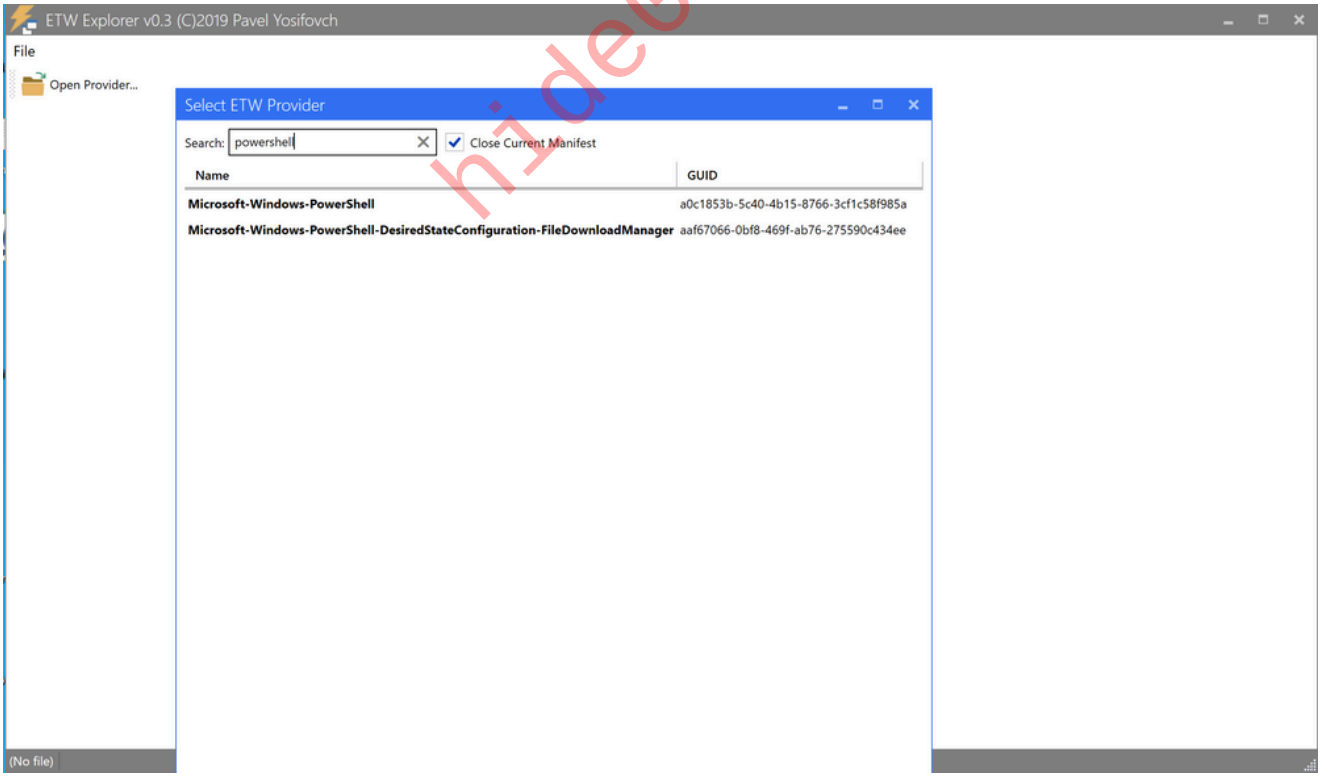
GUI-based alternatives also exist. These are:

1. Using the graphical interface of the `Performance Monitor` tool, we can visualize various running trace sessions. A detailed overview of a specific trace can be accessed simply by double-clicking on it. This reveals all pertinent data related to the trace, from the engaged providers and their activated features to the nature of the trace itself. Additionally, these sessions can be modified to suit our needs by incorporating or eliminating providers. Lastly, we can devise new sessions by opting for the "User Defined" category.





2. ETW Provider metadata can also be viewed through the [EtwExplorer project](#).



Useful Providers

- `Microsoft-Windows-Kernel-Process`: This ETW provider is instrumental in monitoring process-related activity within the Windows kernel. It can aid in detecting unusual process behaviors such as process injection, process hollowing, and other tactics commonly used by malware and advanced persistent threats (APTs).
- `Microsoft-Windows-Kernel-File`: As the name suggests, this provider focuses on file-related operations. It can be employed for detection scenarios involving unauthorized file access, changes to critical system files, or suspicious file operations indicative of exfiltration or ransomware activity.
- `Microsoft-Windows-Kernel-Network`: This ETW provider offers visibility into network-related activity at the kernel level. It's especially useful in detecting network-based attacks such as data exfiltration, unauthorized network connections, and potential signs of command and control (C2) communication.
- `Microsoft-Windows-SMBClient/SMBServer`: These providers monitor Server Message Block (SMB) client and server activity, providing insights into file sharing and network communication. They can be used to detect unusual SMB traffic patterns, potentially indicating lateral movement or data exfiltration.
- `Microsoft-Windows-DotNETRuntime`: This provider focuses on .NET runtime events, making it ideal for identifying anomalies in .NET application execution, potential exploitation of .NET vulnerabilities, or malicious .NET assembly loading.
- `OpenSSH`: Monitoring the OpenSSH ETW provider can provide important insights into Secure Shell (SSH) connection attempts, successful and failed authentications, and potential brute force attacks.
- `Microsoft-Windows-VPN-Client`: This provider enables tracking of Virtual Private Network (VPN) client events. It can be useful for identifying unauthorized or suspicious VPN connections.
- `Microsoft-Windows-PowerShell`: This ETW provider tracks PowerShell execution and command activity, making it invaluable for detecting suspicious PowerShell usage, script block logging, and potential misuse or exploitation.
- `Microsoft-Windows-Kernel-Registry`: This provider monitors registry operations, making it useful for detection scenarios related to changes in registry keys, often associated with persistence mechanisms, malware installation, or system configuration changes.
- `Microsoft-Windows-CodeIntegrity`: This provider monitors code and driver integrity checks, which can be key in identifying attempts to load unsigned or malicious drivers or code.
- `Microsoft-Antimalware-Service`: This ETW provider can be employed to detect potential issues with the antimalware service, including disabled services, configuration changes, or potential evasion techniques employed by malware.
- `WinRM`: Monitoring the Windows Remote Management (WinRM) provider can reveal unauthorized or suspicious remote management activity, often indicative of lateral movement or remote command execution.

- `Microsoft-Windows-TerminalServices-LocalSessionManager`: This provider tracks local Terminal Services sessions, making it useful for detecting unauthorized or suspicious remote desktop activity.
- `Microsoft-Windows-Security-Mitigations`: This provider keeps tabs on the effectiveness and operations of security mitigations in place. It's essential for identifying potential bypass attempts of these security controls.
- `Microsoft-Windows-DNS-Client`: This ETW provider gives visibility into DNS client activity, which is crucial for detecting DNS-based attacks, including DNS tunneling or unusual DNS requests that may indicate C2 communication.
- `Microsoft-Antimalware-Protection`: This provider monitors the operations of antimalware protection mechanisms. It can be used to detect any issues with these mechanisms, such as disabled protection features, configuration changes, or signs of evasion techniques employed by malicious actors.

Restricted Providers

In the realm of Windows operating system security, certain ETW providers are considered "restricted." These providers offer valuable telemetry but are only accessible to processes that carry the requisite permissions. This exclusivity is designed to ensure that sensitive system data remains shielded from potential threats.

One of these high-value, restricted providers is `Microsoft-Windows-Threat-Intelligence`. This provider offers crucial insights into potential security threats and is often leveraged in Digital Forensics and Incident Response (DFIR) operations. However, to access this provider, processes must be privileged with a specific right, known as Protected Process Light (PPL).

According to Elastic: *To be able to run as a PPL, an anti-malware vendor must apply to Microsoft, prove their identity, sign binding legal documents, implement an Early Launch Anti-Malware (ELAM) driver, run it through a test suite, and submit it to Microsoft for a special Authenticode signature. It is not a trivial process. Once this process is complete, the vendor can use this ELAM driver to have Windows protect their anti-malware service by running it as a PPL.* With that said, workarounds to access the `Microsoft-Windows-Threat-Intelligence` provider exist.

In the context of `Microsoft-Windows-Threat-Intelligence`, the benefits of this privileged access are manifold. This provider can record highly granular data about potential threats, enabling security professionals to detect and analyze sophisticated attacks that may have eluded other defenses. Its telemetry can serve as vital evidence in forensic investigations, revealing details about the origin of a threat, the systems and data it interacted with, and the alterations it made. Moreover, by monitoring this provider in real-time, security teams can potentially identify ongoing threats and intervene to mitigate damage.

In the next section, we will utilize ETW to investigate attacks that may evade detection if we rely solely on Sysmon for monitoring and analysis, due to its inherent limitations in capturing certain events.

References

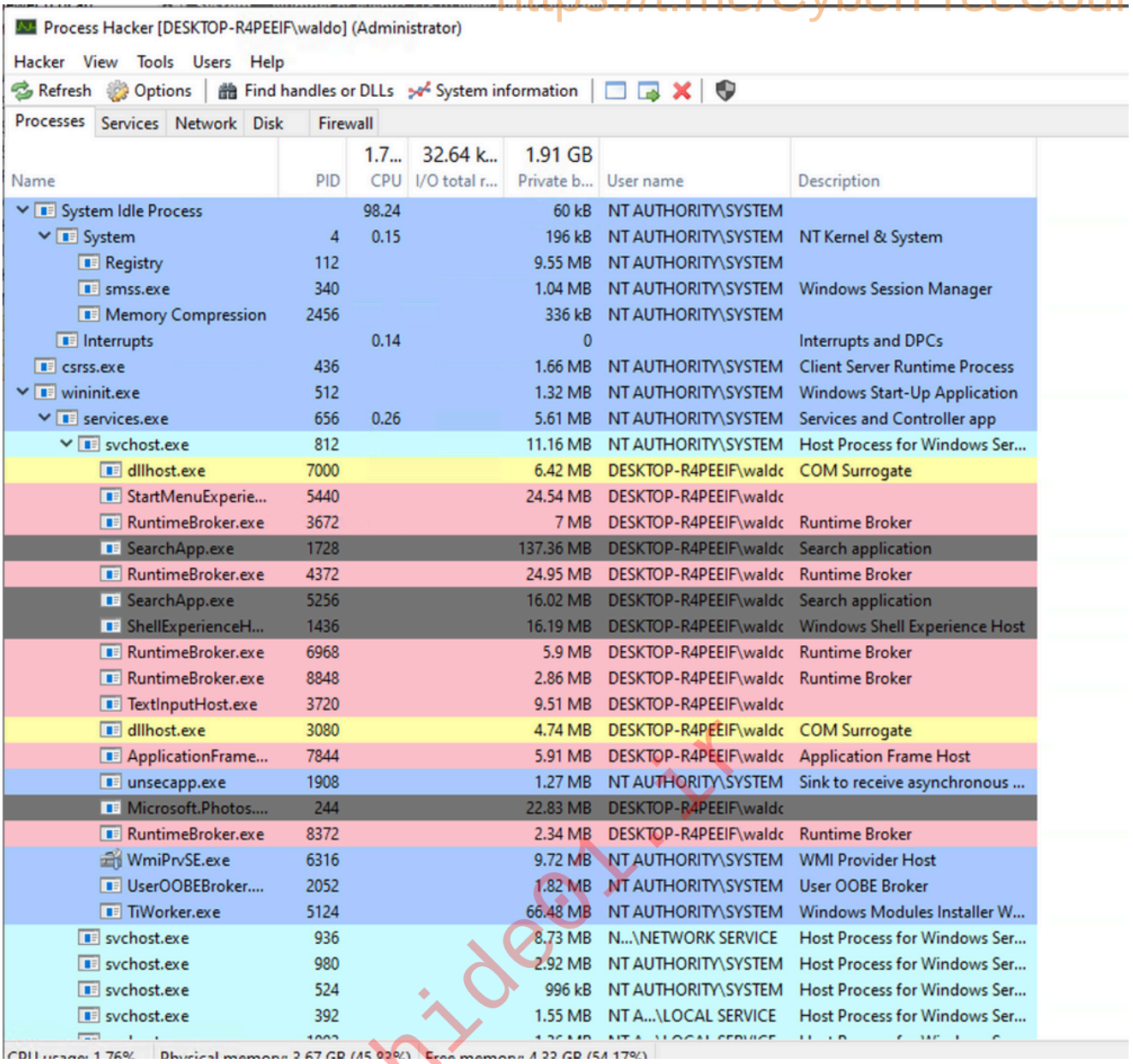
- https://nasbench.medium.com/a-primer-on-event-tracing-for-windows-etw-997725c082bf
- https://bmcder.com/blog/a-begginers-all-inclusive-guide-to-etw

Tapping Into ETW

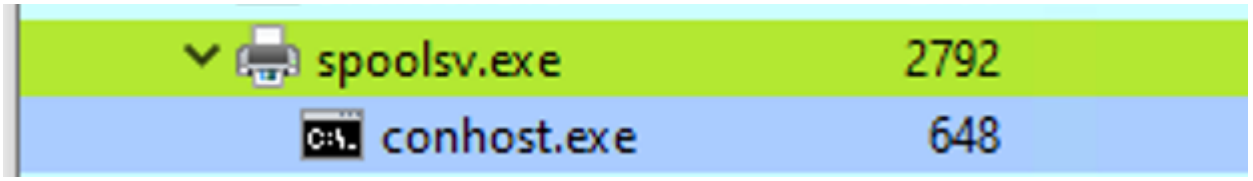
Detection Example 1: Detecting Strange Parent-Child Relationships

Abnormal parent-child relationships among processes can be indicative of malicious activities. In standard Windows environments, certain processes never call or spawn others. For example, it is highly unlikely to see "calc.exe" spawning "cmd.exe" in a normal Windows environment. Understanding these typical parent-child relationships can assist in detecting anomalies. Samir Bousseaden has shared an insightful mind map introducing common parent-child relationships, which can be referenced here.

By utilizing Process Hacker, we can explore parent-child relationships within Windows. Sorting the processes by dropdowns in the Processes view reveals a hierarchical representation of the relationships.



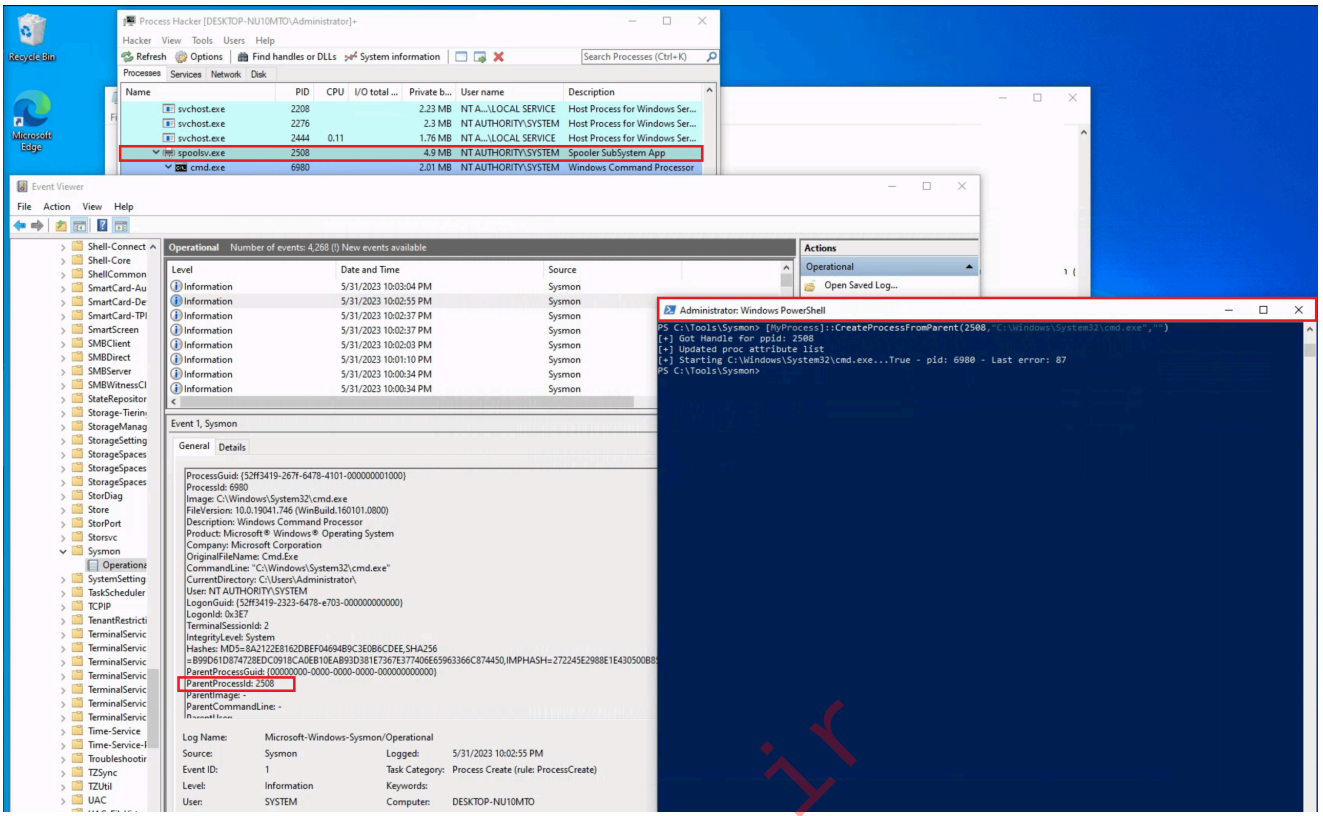
Analyzing these relationships in standard and custom environments enables us to identify deviations from normal patterns. For example, if we observe the "spoolsv.exe" process creating "whoami.exe" instead of its expected behavior of creating a "conhost", it raises suspicion.



To showcase a strange parent-child relationship, where "cmd.exe" appears to be created by "spoolsv.exe" `with no accompanying arguments`, we will utilize an attacking technique called Parent PID Spoofing. Parent PID Spoofing can be executed through the psgetsystem project in the following manner.

```
PS C:\Tools\psgetsystem> powershell -ep bypass
PS C:\Tools\psgetsystem> Import-Module .\psgetsys.ps1
PS C:\Tools\psgetsystem> [MyProcess]::CreateProcessFromParent([Process ID
```

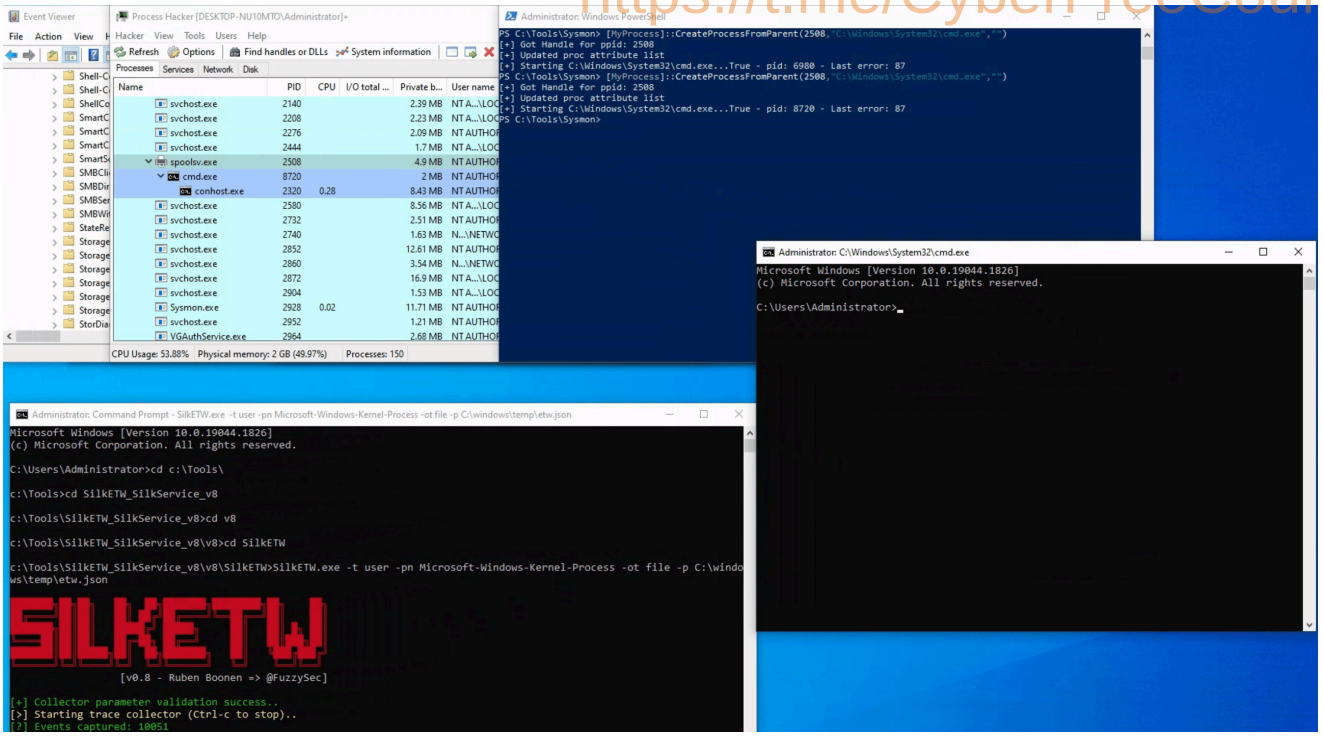
```
of spoolsv.exe],"C:\Windows\System32\cmd.exe","")
```



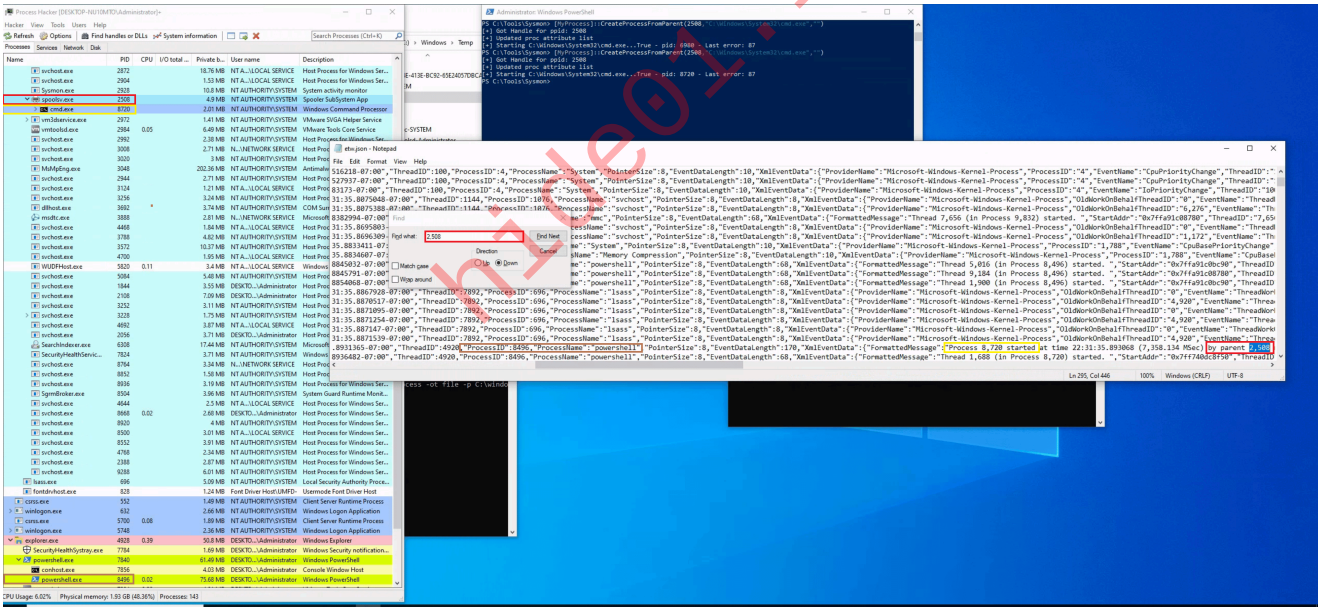
Due to the parent PID spoofing technique we employed, Sysmon Event 1 incorrectly displays `spoolsv.exe` as the parent of `cmd.exe`. However, it was actually `powershell.exe` that created `cmd.exe`.

As we have previously discussed, although Sysmon and event logs provide valuable telemetry for hunting and creating alert rules, they are not the only sources of information. Let's begin by collecting data from the `Microsoft-Windows-Kernel-Process` provider using SilkETW (the provider can be identified using `logman` as we described previously, `logman.exe query providers | findstr "Process"`). After that, we can proceed to simulate the attack again to assess whether ETW can provide us with more accurate information regarding the execution of `cmd.exe`.

```
c:\Tools\SilkETW_SilkService_v8\v8\SilkETW>SilkETW.exe -t user -pn
Microsoft-Windows-Kernel-Process -ot file -p C:\windows\temp\etw.json
```



The `etw.json` file (that includes data from the `Microsoft-Windows-Kernel-Process` provider) seems to contain information about `powershell.exe` being the one who created `cmd.exe`.



It should be noted that SilkETW event logs can be ingested and viewed by Windows Event Viewer through `SilkService` to provide us with deeper and more extensive visibility into the actions performed on a system.

Detection Example 2: Detecting Malicious .NET Assembly Loading

Traditionally, adversaries employed a strategy known as "Living off the Land" (LotL), exploiting legitimate system tools, such as PowerShell, to carry out their malicious

operations. This approach reduces the risk of detection since it involves the use of tools that are native to the system, and therefore less likely to raise suspicion.

However, the cybersecurity community has adapted and developed countermeasures against this strategy.

Responding to these defensive advancements, attackers have developed a new approach that Mandiant labels as "Bring Your Own Land" (BYOL). Instead of relying on the tools already present on a victim's system, threat actors and penetration testers emulating these tactics now employ .NET assemblies executed entirely in memory. This involves creating custom-built tools using languages like C#, rendering them independent of the pre-existing tools on the target system. The "Bring Your Own Land" lands is quite effective for the following reasons:

- Each Windows system comes equipped with a certain version of .NET pre-installed by default.
- A salient feature of .NET is its managed nature, alleviating the need for programmers to manually handle memory management. This attribute is part of the framework's managed code execution process, where the Common Language Runtime (CLR) takes responsibility for key system-level operations such as garbage collection, eliminating memory leaks and ensuring more efficient resource utilization.
- One of the intriguing advantages of using .NET assemblies is their ability to be loaded directly into memory. This means that an executable or DLL does not need to be written physically to the disk - instead, it is executed directly in memory. This behavior minimizes the artifacts left behind on the system and can help bypass some forms of detection that rely on inspecting files written to disk.
- Microsoft has integrated a wide range of libraries into the .NET framework to address numerous common programming challenges. These libraries include functionalities for establishing HTTP connections, implementing cryptographic operations, and enabling inter-process communication (IPC), such as named pipes. These pre-built tools streamline the development process, reduce the likelihood of errors, and make it easier to build robust and efficient applications. Furthermore, for a threat actor, these rich features provide a toolkit for creating more sophisticated and covert attack methods.

A powerful illustration of this BYOL strategy is the "execute-assembly" command implemented in CobaltStrike, a widely-used software platform for Adversary Simulations and Red Team Operations. CobaltStrike's 'execute-assembly' command allows the user to execute .NET assemblies directly from memory, making it an ideal tool for implementing a BYOL strategy.

In a manner akin to how we detected the execution of unmanaged PowerShell scripts through the observation of anomalous `clr.dll` and `clrjit.dll` loading activity in processes that ordinarily wouldn't require them, we can employ a similar approach to identify malicious .NET assembly loading. This is achieved by scrutinizing the activity related to the loading of .NET-associated DLLs, specifically `clr.dll` and `mscoree.dll`.

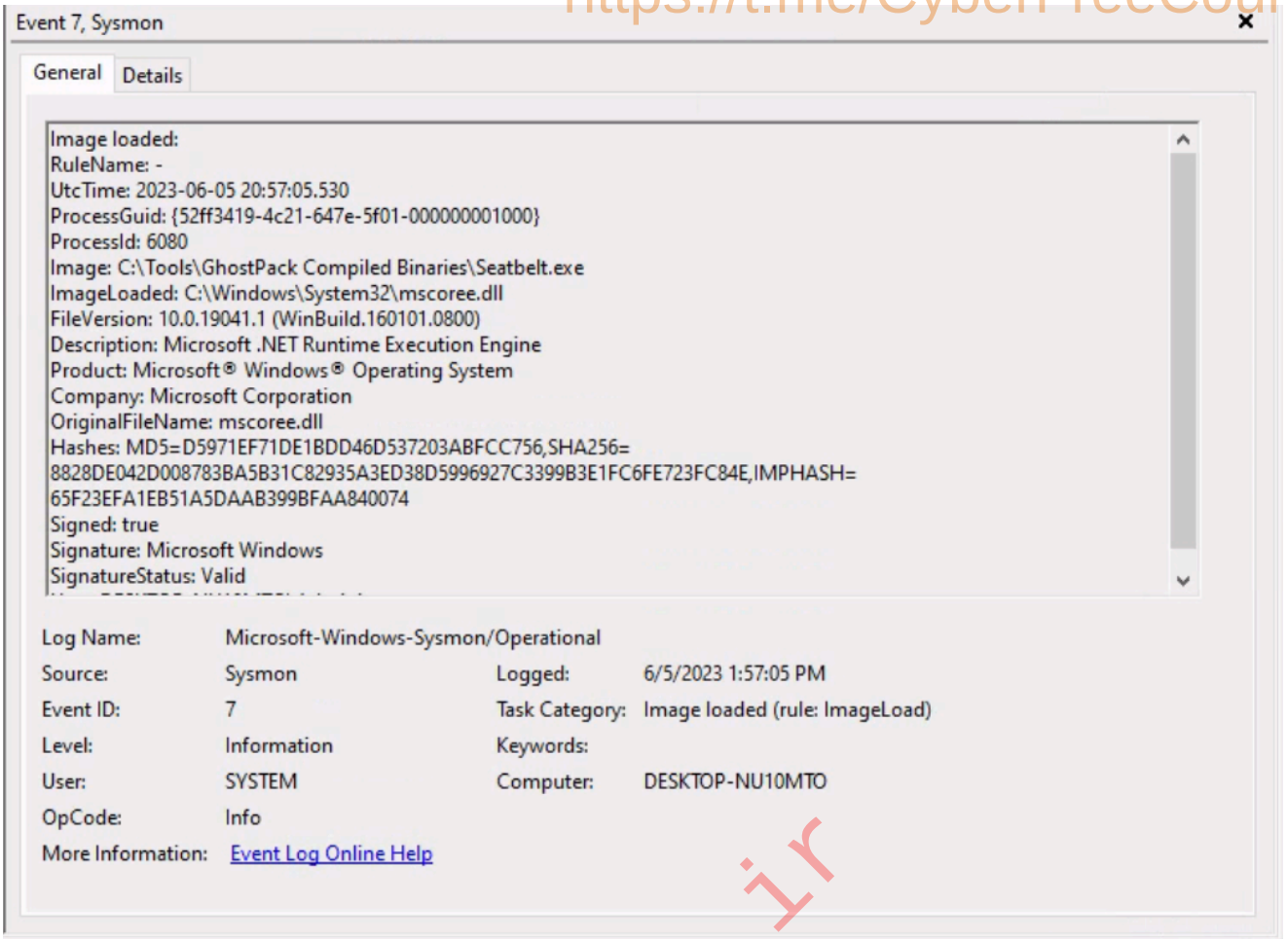
Monitoring the loading of such libraries can help reveal attempts to execute .NET assemblies in unusual or unexpected contexts, which can be a sign of malicious activity. This type of DLL loading behavior can often be detected by leveraging Sysmon's Event ID 7, which corresponds to "Image Loaded" events.

For demonstrative purposes, let's emulate a malicious .NET assembly load by executing a precompiled version of Seatbelt that resides on disk. `Seatbelt` is a well-known .NET assembly, often employed by adversaries who load and execute it in memory to gain situational awareness on a compromised system.

```
PS C:\Tools\GhostPack Compiled Binaries>.\Seatbelt.exe TokenPrivileges

                        %&&@@@&&
                        &&&&&&&%%%,
#&&@@@@@@%%%%%%###############%
                        &%&   %&%%
&////(((&%%%%%#%################//((((###%%%%%%%%%%%%%%%
%%%%%%%%%%%######%%%#%%####%  &%%**#
@////(((&%%%%%%######################((((((((((((((((((
#%#%%%%%%%#######%#%%#######  %&%,,,,,,,,,,,,,,,,
@////(((&%%%%%#%######################((((((((((((((((((
#%#%%%%%%#####%%#%#%%#######  %%%,,,,,,  ,,.   ,,
@////(((&%%%%%%%######################(#(((#(#((((((((((
#####%%%####################  &%%......  ...   ..
@////(((&%%%%%%%###############%######((#(#(####((((((((
#######%##########%#########  %%%......  ...   ..
@////(((&%%%%%#########################(#(#######((#####
###%##%%####################  &%%...............
@////(((&%%%%%%%%###############%#######(#########((#####
#####%######################  %%%..
@////(((&%%%%%%%################
                        &%&   %%%%%      Seatbelt
%////(((&%%%%%%%%#############*
                        &%%&&&%%%%%        v1.2.1         ,
(((&%%%%%%%%%%%%%%%%%,
                         #%%%%##,


====== TokenPrivileges ======

Current Token's Privileges

                     SeIncreaseQuotaPrivilege:  DISABLED
                          SeSecurityPrivilege:  DISABLED
                     SeTakeOwnershipPrivilege:  DISABLED
                        SeLoadDriverPrivilege:  DISABLED
                     SeSystemProfilePrivilege:  DISABLED
                        SeSystemtimePrivilege:  DISABLED
              SeProfileSingleProcessPrivilege:  DISABLED
```

```
              SeIncreaseBasePriorityPrivilege:  DISABLED
                    SeCreatePagefilePrivilege:  DISABLED
                           SeBackupPrivilege:  DISABLED
                          SeRestorePrivilege:  DISABLED
                         SeShutdownPrivilege:  DISABLED
                            SeDebugPrivilege:  SE_PRIVILEGE_ENABLED
                  SeSystemEnvironmentPrivilege:  DISABLED
                       SeChangeNotifyPrivilege:
SE_PRIVILEGE_ENABLED_BY_DEFAULT, SE_PRIVILEGE_ENABLED
                    SeRemoteShutdownPrivilege:  DISABLED
                           SeUndockPrivilege:  DISABLED
                     SeManageVolumePrivilege:  DISABLED
                      SeImpersonatePrivilege:
SE_PRIVILEGE_ENABLED_BY_DEFAULT, SE_PRIVILEGE_ENABLED
                     SeCreateGlobalPrivilege:
SE_PRIVILEGE_ENABLED_BY_DEFAULT, SE_PRIVILEGE_ENABLED
                SeIncreaseWorkingSetPrivilege:  DISABLED
                          SeTimeZonePrivilege:  DISABLED
                SeCreateSymbolicLinkPrivilege:  DISABLED
    SeDelegateSessionUserImpersonatePrivilege:  DISABLED
```

Assuming we have Sysmon configured appropriately to log image loading events (Event ID 7), executing 'Seatbelt.exe' would trigger the loading of key .NET-related DLLs such as 'clr.dll' and 'mscoree.dll'. Sysmon, keenly observing system activities, will log these DLL load operations as Event ID 7 records.

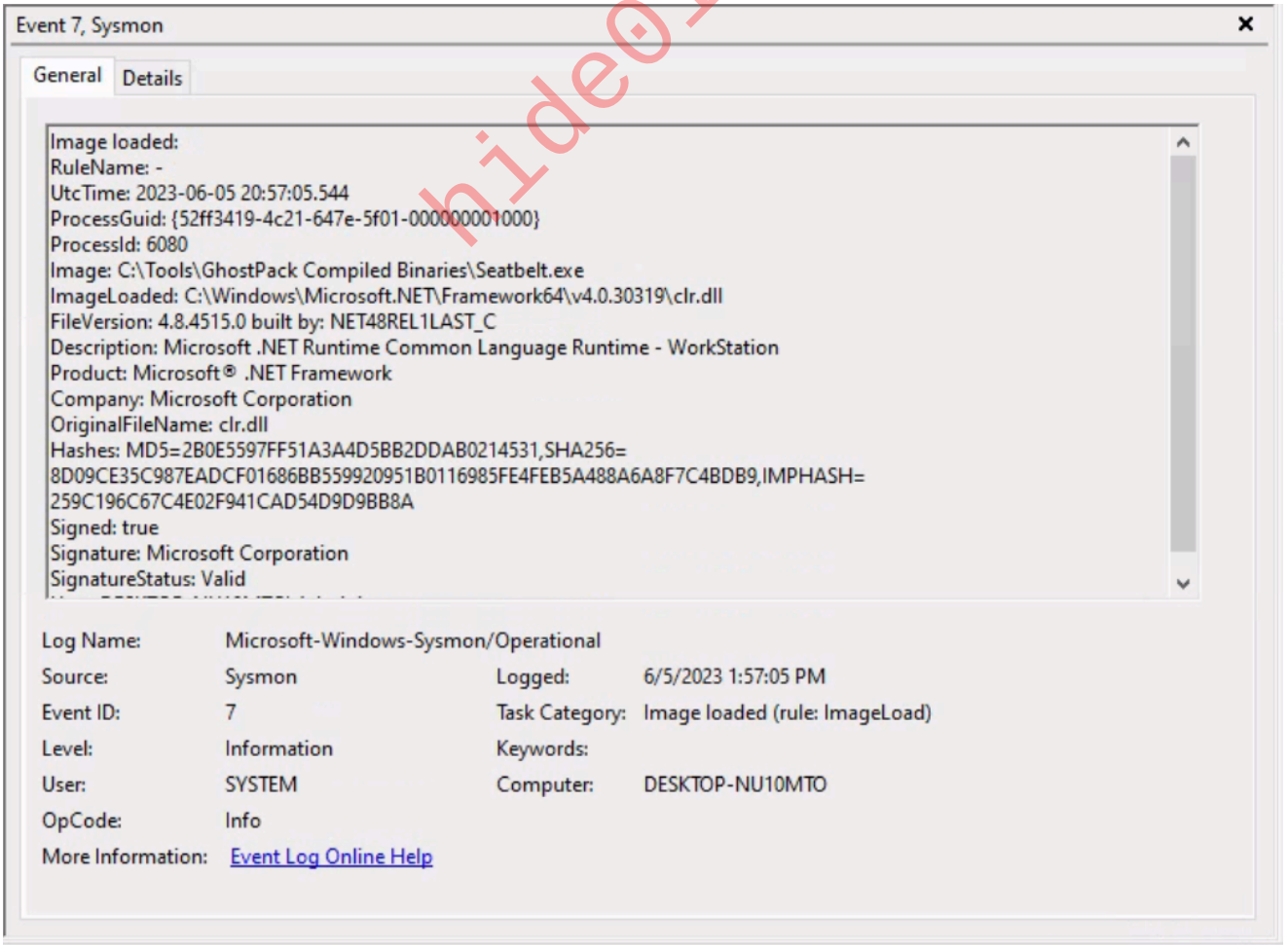


Event 7, Sysmon

General Details

Image loaded:
RuleName: -
UtcTime: 2023-06-05 20:57:05.530
ProcessGuid: {52ff3419-4c21-647e-5f01-000000001000}
ProcessId: 6080
Image: C:\Tools\GhostPack Compiled Binaries\Seatbelt.exe
ImageLoaded: C:\Windows\System32\mscoree.dll
FileVersion: 10.0.19041.1 (WinBuild.160101.0800)
Description: Microsoft .NET Runtime Execution Engine
Product: Microsoft® Windows® Operating System
Company: Microsoft Corporation
OriginalFileName: mscoree.dll
Hashes: MD5=D5971EF71DE1BDD46D537203ABFCC756,SHA256=
8828DE042D008783BA5B31C82935A3ED38D5996927C3399B3E1FC6FE723FC84E,IMPHASH=
65F23EFA1EB51A5DAAB399BFAA840074
Signed: true
Signature: Microsoft Windows
SignatureStatus: Valid

Log Name:	Microsoft-Windows-Sysmon/Operational		
Source:	Sysmon	Logged:	6/5/2023 1:57:05 PM
Event ID:	7	Task Category:	Image loaded (rule: ImageLoad)
Level:	Information	Keywords:	
User:	SYSTEM	Computer:	DESKTOP-NU10MTO
OpCode:	Info		
More Information:	Event Log Online Help		



Event 7, Sysmon

General Details

Image loaded:
RuleName: -
UtcTime: 2023-06-05 20:57:05.544
ProcessGuid: {52ff3419-4c21-647e-5f01-000000001000}
ProcessId: 6080
Image: C:\Tools\GhostPack Compiled Binaries\Seatbelt.exe
ImageLoaded: C:\Windows\Microsoft.NET\Framework64\v4.0.30319\clr.dll
FileVersion: 4.8.4515.0 built by: NET48REL1LAST_C
Description: Microsoft .NET Runtime Common Language Runtime - WorkStation
Product: Microsoft® .NET Framework
Company: Microsoft Corporation
OriginalFileName: clr.dll
Hashes: MD5=2B0E5597FF51A3A4D5BB2DDAB0214531,SHA256=
8D09CE35C987EADCF01686BB559920951B0116985FE4FEB5A488A6A8F7C4BDB9,IMPHASH=
259C196C67C4E02F941CAD54D9D9BB8A
Signed: true
Signature: Microsoft Corporation
SignatureStatus: Valid

Log Name:	Microsoft-Windows-Sysmon/Operational		
Source:	Sysmon	Logged:	6/5/2023 1:57:05 PM
Event ID:	7	Task Category:	Image loaded (rule: ImageLoad)
Level:	Information	Keywords:	
User:	SYSTEM	Computer:	DESKTOP-NU10MTO
OpCode:	Info		
More Information:	Event Log Online Help		

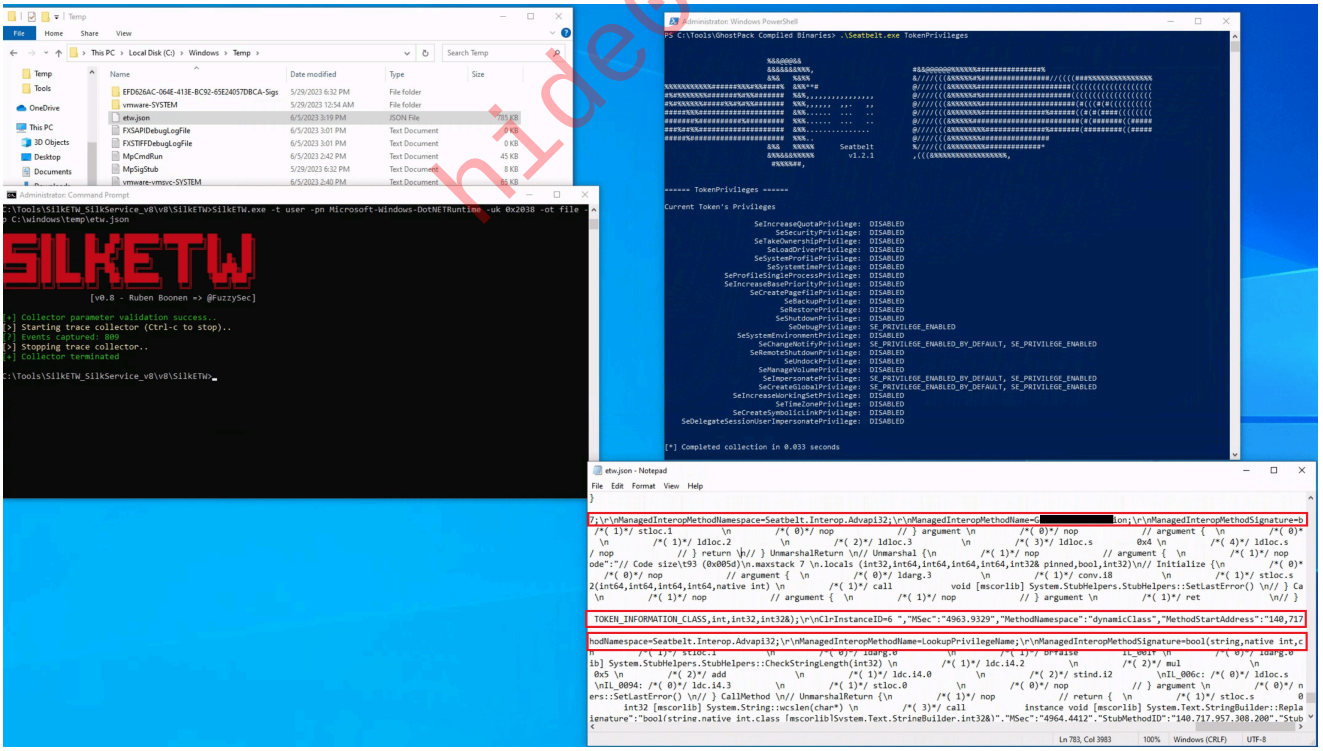
As already mentioned, relying solely on Sysmon Event ID 7 for detecting attacks can be challenging due to the large volume of events it generates (especially if not configured properly). Additionally, while it informs us about the DLLs being loaded, it doesn't provide granular details about the actual content of the loaded .NET assembly.

To augment our visibility and gain deeper insights into the actual assembly being loaded, we can again leverage Event Tracing for Windows (ETW) and specifically the `Microsoft-Windows-DotNETRuntime` provider.

Let's use SilkETW to collect data from the `Microsoft-Windows-DotNETRuntime` provider. After that, we can proceed to simulate the attack again to evaluate whether ETW can furnish us with more detailed and actionable intelligence regarding the loading and execution of the 'Seatbelt' .NET assembly.

```
c:\Tools\SilkETW_SilkService_v8\v8\SilkETW>SilkETW.exe -t user -pn
Microsoft-Windows-DotNETRuntime -uk 0x2038 -ot file -p
C:\windows\temp\etw.json
```

The `etw.json` file (that includes data from the `Microsoft-Windows-DotNETRuntime` provider) seems to contain a wealth of information about the loaded assembly, including method names.



It's worth noting that in our current SilkETW configuration, we're not capturing the entirety of events from the "Microsoft-Windows-DotNETRuntime" provider. Instead, we're selectively targeting a specific subset (indicated by `0x2038`), which includes: `JitKeyword`, `InteropKeyword`, `LoaderKeyword`, and `NGenKeyword`.

- The `JitKeyword` relates to the Just-In-Time (JIT) compilation events, providing information on the methods being compiled at runtime. This could be particularly useful for understanding the execution flow of the .NET assembly.
- The `InteropKeyword` refers to Interoperability events, which come into play when managed code interacts with unmanaged code. These events could provide insights into potential interactions with native APIs or other unmanaged components.
- `LoaderKeyword` events provide details on the assembly loading process within the .NET runtime, which can be vital for understanding what .NET assemblies are being loaded and potentially executed.
- Lastly, the `NGenKeyword` corresponds to Native Image Generator (NGen) events, which are concerned with the creation and usage of precompiled .NET assemblies. Monitoring these could help detect scenarios where attackers use precompiled .NET assemblies to evade JIT-related detections.

This blog post provides valuable perspectives on SilkETW as well as the identification of malware based on .NET.

Practical Exercise

Navigate to the bottom of this section and click on `Click here to spawn the target system!`

Then, RDP to `[Target IP]` using the provided credentials and answer the question below.

```
xfreerdp /u:Administrator /p:'HTB_@cad3my_lab_W1n10_r00t!@0' /v:[Target IP] /dynamic-resolution
```


Get-WinEvent

Understanding the importance of mass analysis of Windows Event Logs and Sysmon logs is pivotal in the realm of cybersecurity, especially in Incident Response (IR) and threat hunting scenarios. These logs hold invaluable information about the state of your systems, user activities, potential threats, system changes, and troubleshooting information. However, these logs can also be voluminous and unwieldy. For large-scale organizations, it's not uncommon to generate millions of logs each day. Hence, to distill useful information from these logs, we require efficient tools and techniques to analyze these logs en masse.

One of these tools is the the Get-WinEvent cmdlet in PowerShell.

Using Get-WinEvent

The `Get-WinEvent` cmdlet is an indispensable tool in PowerShell for querying Windows Event logs en masse. The cmdlet provides us with the capability to retrieve different types of event logs, including classic Windows event logs like System and Application logs, logs generated by Windows Event Log technology, and Event Tracing for Windows (ETW) logs.

To quickly identify the available logs, we can leverage the `-ListLog` parameter in conjunction with the Get-WinEvent cmdlet. By specifying `*` as the parameter value, we retrieve all logs without applying any filtering criteria. This allows us to obtain a comprehensive list of logs and their associated properties. By executing the following command, we can retrieve the list of logs and display essential properties such as `LogName`, `RecordCount`, `IsClassicLog`, `IsEnabled`, `LogMode`, and `LogType`. The `|` character is a pipe operator. It is used to pass the output of one command (in this case, the `Get-WinEvent` command) to another command (in this case, the `Select-Object` command).

```
PS C:\Users\Administrator> Get-WinEvent -ListLog * | Select-Object
LogName, RecordCount, IsClassicLog, IsEnabled, LogMode, LogType | Format-
Table -AutoSize

LogName
RecordCount IsClassicLog IsEnabled  LogMode        LogType
-------
---------- ----------- ---------  -------        -------
Windows PowerShell
2916         True      True Circular Administrative
System
1786         True      True Circular Administrative
Security
8968         True      True Circular Administrative
Key Management Service
0         True      True Circular Administrative
Internet Explorer
0         True      True Circular Administrative
HardwareEvents
0         True      True Circular Administrative
Application
2079         True      True Circular Administrative
Windows Networking Vpn Plugin Platform/OperationalVerbose
False     False Circular    Operational
Windows Networking Vpn Plugin Platform/Operational
False     False Circular    Operational
SMSApi
0        False      True Circular    Operational
Setup
16        False      True Circular    Operational
OpenSSH/Operational
```

```
0        False      True Circular    Operational
OpenSSH/Admin
0        False      True Circular Administrative
Network Isolation Operational
False     False Circular    Operational
Microsoft-WindowsPhone-Connectivity-WiFiConnSvc-Channel
0        False      True Circular    Operational
Microsoft-Windows-WWAN-SVC-Events/Operational
0        False      True Circular    Operational
Microsoft-Windows-WPD-MTPClassDriver/Operational
0        False      True Circular    Operational
Microsoft-Windows-WPD-CompositeClassDriver/Operational
0        False      True Circular    Operational
Microsoft-Windows-WPD-ClassInstaller/Operational
0        False      True Circular    Operational
Microsoft-Windows-Workplace Join/Admin
0        False      True Circular Administrative
Microsoft-Windows-WorkFolders/WHC
0        False      True Circular    Operational
Microsoft-Windows-WorkFolders/Operational
0        False      True Circular    Operational
Microsoft-Windows-Wordpad/Admin
False     False Circular    Operational
Microsoft-Windows-WMPNSS-Service/Operational
0        False      True Circular    Operational
Microsoft-Windows-WMI-Activity/Operational
895        False      True Circular    Operational
Microsoft-Windows-wmbclass/Trace
False     False Circular    Operational
Microsoft-Windows-WLAN-AutoConfig/Operational
0        False      True Circular    Operational
Microsoft-Windows-Wired-AutoConfig/Operational
0        False      True Circular    Operational
Microsoft-Windows-Winsock-WS2HELP/Operational
0        False      True Circular    Operational
Microsoft-Windows-Winsock-NameResolution/Operational
False     False Circular    Operational
Microsoft-Windows-Winsock-AFD/Operational
False     False Circular    Operational
Microsoft-Windows-WinRM/Operational
230        False      True Circular    Operational
Microsoft-Windows-WinNat/Oper
False     False Circular    Operational
Microsoft-Windows-Winlogon/Operational
648        False      True Circular    Operational
Microsoft-Windows-WinINet-Config/ProxyConfigChanged
2        False      True Circular    Operational
--- SNIP ---
```

This command provides us with valuable information about each log, including the name of the log, the number of records present, whether the log is in the classic `.evt` format or the newer `.evtx` format, its enabled status, the log mode (Circular, Retain, or AutoBackup), and the log type (Administrative, Analytical, Debug, or Operational).

Additionally, we can explore the event log providers associated with each log using the `-ListProvider` parameter. Event log providers serve as the sources of events within the logs. Executing the following command allows us to retrieve the list of providers and their respective linked logs.

```
PS C:\Users\Administrator> Get-WinEvent -ListProvider * | Format-Table -
AutoSize

Name
LogLinks
----
--------
PowerShell
{Windows PowerShell}
Workstation
{System}
WMIxWDM
{System}
WinNat
{System}
Windows Script Host
{System}
Microsoft-Windows-IME-OEDCompiler
{Microsoft-Windows-IME-OEDCompiler/Analytic}
Microsoft-Windows-DeviceSetupManager
{Microsoft-Windows-DeviceSetupManager/Operat...
Microsoft-Windows-Search-ProfileNotify
{Application}
Microsoft-Windows-Eventlog
{System, Security, Setup, Microsoft-Windows-...
Microsoft-Windows-Containers-BindFlt
{Microsoft-Windows-Containers-BindFlt/Operat...
Microsoft-Windows-NDF-HelperClassDiscovery
{Microsoft-Windows-NDF-HelperClassDiscovery/...
Microsoft-Windows-FirstUX-PerfInstrumentation
{FirstUXPerf-Analytic}
--- SNIP ---
```


This command provides us with an overview of the available providers and their associations with specific logs. It enables us to identify providers of interest for filtering purposes.

Now, let's focus on retrieving specific event logs using the Get-WinEvent cmdlet. At its most basic, Get-WinEvent retrieves event logs from local or remote computers. The examples below demonstrate how to retrieve events from various logs.

1. **Retrieving events from the System log**

```
PS C:\Users\Administrator> Get-WinEvent -LogName 'System' -MaxEvents 50 |
Select-Object TimeCreated, ID, ProviderName, LevelDisplayName, Message |
Format-Table -AutoSize

TimeCreated            Id ProviderName
LevelDisplayName Message
   -----------            -- ------------                                ----
------------ -------
6/2/2023 9:41:42 AM    16 Microsoft-Windows-Kernel-General
Information      The access history in hive \??
\C:\Users\Administrator\AppData\Local\Packages\MicrosoftWindows.Client.CBS
_cw5...
6/2/2023 9:38:32 AM    16 Microsoft-Windows-Kernel-General
Information      The access history in hive \??
\C:\Users\Administrator\AppData\Local\Packages\Microsoft.Windows.ShellExpe
rien...
6/2/2023 9:38:32 AM 10016 Microsoft-Windows-DistributedCOM         Warning
The machine-default permission settings do not grant Local Activation
permission for the COM Server applicat...
6/2/2023 9:37:31 AM    16 Microsoft-Windows-Kernel-General
Information      The access history in hive \??
\C:\Users\Administrator\AppData\Local\Packages\Microsoft.WindowsAlarms_8we
kyb3...
6/2/2023 9:37:31 AM    16 Microsoft-Windows-Kernel-General
Information      The access history in hive \??
\C:\Users\Administrator\AppData\Local\Packages\microsoft.windowscommunicat
ions...
6/2/2023 9:37:31 AM    16 Microsoft-Windows-Kernel-General
Information      The access history in hive \??
\C:\Users\Administrator\AppData\Local\Packages\Microsoft.Windows.ContentDe
live...
6/2/2023 9:36:35 AM    16 Microsoft-Windows-Kernel-General
Information      The access history in hive \??
\C:\Users\Administrator\AppData\Local\Packages\Microsoft.YourPhone_8wekyb3
d8bb...
6/2/2023 9:36:32 AM    16 Microsoft-Windows-Kernel-General
Information      The access history in hive \??
\C:\Users\Administrator\AppData\Local\Packages\Microsoft.AAD.BrokerPlugin_
cw5n...
6/2/2023 9:36:30 AM    16 Microsoft-Windows-Kernel-General
Information      The access history in hive \??
\C:\Users\Administrator\AppData\Local\Packages\Microsoft.Windows.Search_cw
5n1h...
```

```
6/2/2023 9:36:29 AM    16 Microsoft-Windows-Kernel-General
Information      The access history in hive \??
\C:\Users\Administrator\AppData\Local\Packages\Microsoft.Windows.StartMenu
Expe...
6/2/2023 9:36:14 AM    16 Microsoft-Windows-Kernel-General
Information      The access history in hive \??
\C:\Users\Administrator\AppData\Local\Microsoft\Windows\UsrClass.dat was
clear...
6/2/2023 9:36:14 AM    16 Microsoft-Windows-Kernel-General
Information      The access history in hive \??
\C:\Users\Administrator\ntuser.dat was cleared updating 2366 keys and
creating...
6/2/2023 9:36:14 AM  7001 Microsoft-Windows-Winlogon
Information      User Logon Notification for Customer Experience
Improvement Program
6/2/2023 9:33:04 AM    16 Microsoft-Windows-Kernel-General
Information      The access history in hive \??
\C:\Windows\AppCompat\Programs\Amcache.hve was cleared updating 920 keys
and c...
6/2/2023 9:31:54 AM    16 Microsoft-Windows-Kernel-General
Information      The access history in hive \??
\C:\Windows\ServiceProfiles\NetworkService\AppData\Local\Microsoft\Windows
\Del...
6/2/2023 9:30:23 AM    16 Microsoft-Windows-Kernel-General
Information      The access history in hive \??
\C:\Windows\System32\config\COMPONENTS was cleared updating 54860 keys and
cre...
6/2/2023 9:30:16 AM    15 Microsoft-Windows-Kernel-General
Information      Hive \SystemRoot\System32\config\DRIVERS was reorganized
with a starting size of 3956736 bytes and an ending...
6/2/2023 9:30:10 AM  1014 Microsoft-Windows-DNS-Client             Warning
Name resolution for the name settings-win.data.microsoft.com timed out
after none of the configured DNS serv...
6/2/2023 9:29:54 AM  7026 Service Control Manager
Information      The following boot-start or system-start driver(s) did
not load: ...
6/2/2023 9:29:54 AM 10148 Microsoft-Windows-WinRM
Information      The WinRM service is listening for WS-Management
requests. ...
6/2/2023 9:29:51 AM 51046 Microsoft-Windows-DHCPv6-Client
Information      DHCPv6 client service is started
   --- SNIP ---
```


This example retrieves the first 50 events from the System log. It selects specific properties, including the event's creation time, ID, provider name, level display name, and message. This facilitates easier analysis and troubleshooting.

2. **Retrieving events from Microsoft-Windows-WinRM/Operational**

```
PS C:\Users\Administrator> Get-WinEvent -LogName 'Microsoft-Windows-
WinRM/Operational' -MaxEvents 30 | Select-Object TimeCreated, ID,
ProviderName, LevelDisplayName, Message | Format-Table -AutoSize

TimeCreated             Id ProviderName            LevelDisplayName Message
   -----------             -- ------------            ---------------- ----
---
6/2/2023 9:30:15 AM    132 Microsoft-Windows-WinRM Information      WSMan
operation Enumeration completed successfully
6/2/2023 9:30:15 AM    145 Microsoft-Windows-WinRM Information      WSMan
operation Enumeration started with resourceUri...
6/2/2023 9:30:15 AM    132 Microsoft-Windows-WinRM Information      WSMan
operation Enumeration completed successfully
6/2/2023 9:30:15 AM    145 Microsoft-Windows-WinRM Information      WSMan
operation Enumeration started with resourceUri...
6/2/2023 9:29:54 AM    209 Microsoft-Windows-WinRM Information      The
Winrm service started successfully
   --- SNIP ---
```

In this example, events are retrieved from the Microsoft-Windows-WinRM/Operational log. The command retrieves the first 30 events and selects relevant properties for display, including the event's creation time, ID, provider name, level display name, and message.

To retrieve the oldest events, instead of manually sorting the results, we can utilize the `-Oldest` parameter with the Get-WinEvent cmdlet. This parameter allows us to retrieve the first events based on their chronological order. The following command demonstrates how to retrieve the oldest 30 events from the 'Microsoft-Windows-WinRM/Operational' log.


```
PS C:\Users\Administrator> Get-WinEvent -LogName 'Microsoft-Windows-
WinRM/Operational' -Oldest -MaxEvents 30 | Select-Object TimeCreated, ID,
ProviderName, LevelDisplayName, Message | Format-Table -AutoSize

TimeCreated             Id ProviderName            LevelDisplayName Message
   -----------             -- ------------            ---------------- ----
---
8/3/2022 4:41:38 PM  145 Microsoft-Windows-WinRM Information      WSMan
operation Enumeration started with resourceUri ...
8/3/2022 4:41:42 PM  254 Microsoft-Windows-WinRM Information      Activity
Transfer
8/3/2022 4:41:42 PM  161 Microsoft-Windows-WinRM Error            The
client cannot connect to the destination specifie...
8/3/2022 4:41:42 PM  142 Microsoft-Windows-WinRM Error            WSMan
operation Enumeration failed, error code 215085...
8/3/2022 9:51:03 AM  145 Microsoft-Windows-WinRM Information      WSMan
operation Enumeration started with resourceUri ...
8/3/2022 9:51:07 AM  254 Microsoft-Windows-WinRM Information      Activity
```

```
Transfer
```

3. **Retrieving events from .evtx Files**

If you have an exported `.evtx` file from another computer or you have backed up an existing log, you can utilize the Get-WinEvent cmdlet to read and query those logs. This capability is particularly useful for auditing purposes or when you need to analyze logs within scripts.

To retrieve log entries from a `.evtx file`, you need to provide the log file's path using the `-Path` parameter. The example below demonstrates how to read events from the 'C:\Tools\chainsaw\EVTX-ATTACK-SAMPLES\Execution\exec_sysmon_1_lolbin_pcalua.evtx' file, which represents an exported Windows PowerShell log.

```
PS C:\Users\Administrator> Get-WinEvent -Path 'C:\Tools\chainsaw\EVTX-
ATTACK-SAMPLES\Execution\exec_sysmon_1_lolbin_pcalua.evtx' -MaxEvents 5 |
Select-Object TimeCreated, ID, ProviderName, LevelDisplayName, Message |
Format-Table -AutoSize

TimeCreated           Id ProviderName          LevelDisplayName Message
   -----------           -- ------------          ---------------- ----
---
5/12/2019 10:01:51 AM  1 Microsoft-Windows-Sysmon Information      Process
Create:...
5/12/2019 10:01:50 AM  1 Microsoft-Windows-Sysmon Information      Process
Create:...
5/12/2019 10:01:43 AM  1 Microsoft-Windows-Sysmon Information      Process
Create:...
```

By specifying the path of the log file using the `-Path` parameter, we can retrieve events from that specific file. The command selects relevant properties and formats the output for easier analysis, displaying the event's creation time, ID, provider name, level display name, and message.

4. **Filtering events with FilterHashtable**

To filter Windows event logs, we can use the `-FilterHashtable` parameter, which enables us to define specific conditions for the logs we want to retrieve.

```
PS C:\Users\Administrator> Get-WinEvent -FilterHashtable
@{LogName='Microsoft-Windows-Sysmon/Operational'; ID=1,3} | Select-Object
TimeCreated, ID, ProviderName, LevelDisplayName, Message | Format-Table -
AutoSize
```

```
TimeCreated           Id ProviderName             LevelDisplayName Message
   -----------           -- ------------             ---------------- ----
---
6/2/2023 10:40:09 AM   1 Microsoft-Windows-Sysmon Information      Process
Create:...
6/2/2023 10:39:01 AM   1 Microsoft-Windows-Sysmon Information      Process
Create:...
6/2/2023 10:34:12 AM   1 Microsoft-Windows-Sysmon Information      Process
Create:...
6/2/2023 10:33:26 AM   1 Microsoft-Windows-Sysmon Information      Process
Create:...
6/2/2023 10:33:16 AM   1 Microsoft-Windows-Sysmon Information      Process
Create:...
6/2/2023 9:36:10 AM    3 Microsoft-Windows-Sysmon Information      Network
connection detected:...
5/29/2023 6:30:26 PM   1 Microsoft-Windows-Sysmon Information      Process
Create:...
5/29/2023 6:30:24 PM   3 Microsoft-Windows-Sysmon Information      Network
connection detected:...
```

The command above retrieves events with IDs 1 and 3 from the `Microsoft-Windows-Sysmon/Operational` event log, selects specific properties from those events, and displays them in a table format. **Note**: If we observe Sysmon event IDs 1 and 3 (related to "dangerous" or uncommon binaries) occurring within a short time frame, it could potentially indicate the presence of a process communicating with a Command and Control (C2) server.

For exported events the equivalent command is the following.

```
PS C:\Users\Administrator> Get-WinEvent -FilterHashtable
@{Path='C:\Tools\chainsaw\EVTX-ATTACK-
SAMPLES\Execution\sysmon_mshta_sharpshooter_stageless_meterpreter.evtx';
ID=1,3} | Select-Object TimeCreated, ID, ProviderName, LevelDisplayName,
Message | Format-Table -AutoSize

TimeCreated           Id ProviderName             LevelDisplayName Message
   -----------           -- ------------             ---------------- ----
---
6/15/2019 12:14:32 AM  1 Microsoft-Windows-Sysmon Information      Process
Create:...
6/15/2019 12:13:44 AM  3 Microsoft-Windows-Sysmon Information      Network
connection detected:...
6/15/2019 12:13:42 AM  1 Microsoft-Windows-Sysmon Information      Process
Create:...
```

Note: These logs are related to a process communicating with a Command and Control (C2) server right after it was created.

If we want the get event logs based on a date range (`5/28/23 - 6/2/2023`), this can be done as follows.

```
    PS C:\Users\Administrator> $startDate = (Get-Date -Year 2023 -Month 5
-Day 28).Date
    PS C:\Users\Administrator> $endDate   = (Get-Date -Year 2023 -Month 6
-Day 3).Date
    PS C:\Users\Administrator> Get-WinEvent -FilterHashtable
@{LogName='Microsoft-Windows-Sysmon/Operational'; ID=1,3;
StartTime=$startDate; EndTime=$endDate} | Select-Object TimeCreated, ID,
ProviderName, LevelDisplayName, Message | Format-Table -AutoSize

    TimeCreated           Id ProviderName             LevelDisplayName
Message
   -----------           -- ------------             ---------------- ----
---
6/2/2023 3:26:56 PM    1 Microsoft-Windows-Sysmon Information      Process
Create:...
6/2/2023 3:25:20 PM    1 Microsoft-Windows-Sysmon Information      Process
Create:...
6/2/2023 3:25:20 PM    1 Microsoft-Windows-Sysmon Information      Process
Create:...
6/2/2023 3:24:13 PM    1 Microsoft-Windows-Sysmon Information      Process
Create:...
6/2/2023 3:24:13 PM    1 Microsoft-Windows-Sysmon Information      Process
Create:...
6/2/2023 3:23:41 PM    1 Microsoft-Windows-Sysmon Information      Process
Create:...
6/2/2023 3:20:27 PM    1 Microsoft-Windows-Sysmon Information      Process
Create:...
6/2/2023 3:20:26 PM    1 Microsoft-Windows-Sysmon Information      Process
Create:...
   --- SNIP ---
```


Note: The above will filter between the start date inclusive and the end date exclusive. That's why we specified June 3rd and not 2nd.

5. **Filtering events with FilterHashtable & XML**

Consider an intrusion detection scenario where a suspicious network connection to a particular IP (`52.113.194.132`) has been identified. With Sysmon installed, you can use Event ID 3 (Network Connection) logs to investigate the potential threat.

```
PS C:\Users\Administrator> Get-WinEvent -FilterHashtable
@{LogName='Microsoft-Windows-Sysmon/Operational'; ID=3} |
`ForEach-Object {
$xml = [xml]$_.ToXml()
$eventData = $xml.Event.EventData.Data
New-Object PSObject -Property @{
       SourceIP = $eventData | Where-Object {$_.Name -eq "SourceIp"} |
Select-Object -ExpandProperty '#text'
       DestinationIP = $eventData | Where-Object {$_.Name -eq
"DestinationIp"} | Select-Object -ExpandProperty '#text'
       ProcessGuid = $eventData | Where-Object {$_.Name -eq "ProcessGuid"}
| Select-Object -ExpandProperty '#text'
       ProcessId = $eventData | Where-Object {$_.Name -eq "ProcessId"} |
Select-Object -ExpandProperty '#text'
}
}  | Where-Object {$_.DestinationIP -eq "52.113.194.132"}

DestinationIP  ProcessId SourceIP       ProcessGuid
   -------------  --------- --------       -----------
52.113.194.132 9196      10.129.205.123 {52ff3419-51ad-6475-1201-
000000000e00}
52.113.194.132 5996      10.129.203.180 {52ff3419-54f3-6474-3d03-
000000000c00}
```


This script will retrieve all Sysmon network connection events (ID 3), parse the XML data for each event to retrieve specific details (source IP, destination IP, Process GUID, and Process ID), and filter the results to include only events where the destination IP matches the suspected IP.

Further, we can use the `ProcessGuid` to trace back the original process that made the connection, enabling us to understand the process tree and identify any malicious executables or scripts.

You might wonder how we could have been aware of `Event.EventData.Data`. The Windows XML EventLog (EVTX) format can be found here.

In the "Tapping Into ETW" section we were looking for anomalous `clr.dll` and `mscoree.dll` loading activity in processes that ordinarily wouldn't require them. The command below is leveraging Sysmon's Event ID 7 to detect the loading of abovementioned DLLs.

```
PS C:\Users\Administrator> $Query = @"
        <QueryList>
                <Query Id="0">
                        <Select Path="Microsoft-Windows-
Sysmon/Operational">*[System[(EventID=7)]] and *
```

```
[EventData[Data='mscoree.dll']] or *[EventData[Data='clr.dll']]
                        </Select>
                </Query>
        </QueryList>
        "@
PS C:\Users\Administrator> Get-WinEvent -FilterXml $Query | ForEach-Object
{Write-Host $_.Message `n}
Image loaded:
RuleName: -
UtcTime: 2023-06-05 22:23:16.560
ProcessGuid: {52ff3419-6054-647e-aa02-000000001000}
ProcessId: 2936
Image: C:\Tools\GhostPack Compiled Binaries\Seatbelt.exe
ImageLoaded: C:\Windows\Microsoft.NET\Framework64\v4.0.30319\clr.dll
FileVersion: 4.8.4515.0 built by: NET48REL1LAST_C
Description: Microsoft .NET Runtime Common Language Runtime -
WorkStation
Product: Microsoft® .NET Framework
Company: Microsoft Corporation
OriginalFileName: clr.dll
Hashes:
MD5=2B0E5597FF51A3A4D5BB2DDAB0214531,SHA256=8D09CE35C987EADCF01686BB559920
951B0116985FE4FEB5A488A6A8F7C4BDB9,IMPHASH=259C196C67C4E02F941CAD54D9D9BB8
A
Signed: true
Signature: Microsoft Corporation
SignatureStatus: Valid
User: DESKTOP-NU10MTO\Administrator

Image loaded:
RuleName: -
UtcTime: 2023-06-05 22:23:16.544
ProcessGuid: {52ff3419-6054-647e-aa02-000000001000}
ProcessId: 2936
Image: C:\Tools\GhostPack Compiled Binaries\Seatbelt.exe
ImageLoaded: C:\Windows\System32\mscoree.dll
FileVersion: 10.0.19041.1 (WinBuild.160101.0800)
Description: Microsoft .NET Runtime Execution Engine
Product: Microsoft® Windows® Operating System
Company: Microsoft Corporation
OriginalFileName: mscoree.dll
Hashes:
MD5=D5971EF71DE1BDD46D537203ABFCC756,SHA256=8828DE042D008783BA5B31C82935A3
ED38D5996927C3399B3E1FC6FE723FC84E,IMPHASH=65F23EFA1EB51A5DAAB399BFAA84007
4
Signed: true
Signature: Microsoft Windows
SignatureStatus: Valid
User: DESKTOP-NU10MTO\Administrator
```

```
--- SNIP ---
```

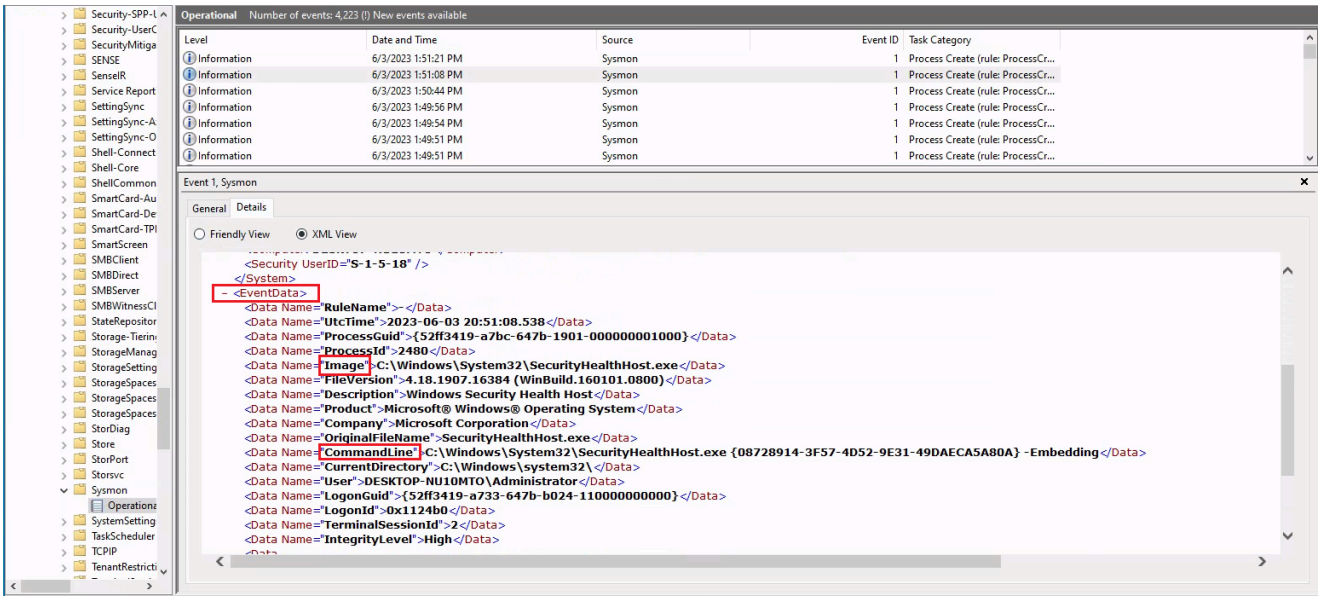
6. **Filtering events with FilterXPath**

To use XPath queries with Get-WinEvent, we need to use the `-FilterXPath` parameter. This allows us to craft an XPath query to filter the event logs.

For instance, if we want to get Process Creation (Sysmon Event ID 1) events in the Sysmon log to identify installation of any Sysinterals tool we can use the command below. **Note**: During the installation of a Sysinternals tool the user must accept the presented EULA. The acceptance action involves the registry key included in the command below.

```
PS C:\Users\Administrator> Get-WinEvent -LogName 'Microsoft-Windows-Sysmon/Operational' -FilterXPath "*[EventData[Data[@Name='Image']='C:\Windows\System32\reg.exe']] and *[EventData[Data[@Name='CommandLine']='`"C:\Windows\system32\reg.exe`" ADD HKCU\Software\Sysinternals /v EulaAccepted /t REG_DWORD /d 1 /f']]" | Select-Object TimeCreated, ID, ProviderName, LevelDisplayName, Message | Format-Table -AutoSize

TimeCreated             Id ProviderName                LevelDisplayName Message
-----------             -- ------------                ---------------- ----
5/29/2023 12:44:46 AM  1 Microsoft-Windows-Sysmon Information      Process Create:...
5/29/2023 12:29:53 AM  1 Microsoft-Windows-Sysmon Information      Process Create:...
```


Note: `Image` and `CommandLine` can be identified by browsing the XML representation of any Sysmon event with ID 1 through, for example, Event Viewer.



Lastly, suppose we want to investigate any network connections to a particular suspicious IP address (`52.113.194.132`) that Sysmon has logged. To do that we could use the following command.

```
PS C:\Users\Administrator> Get-WinEvent -LogName 'Microsoft-Windows-
Sysmon/Operational' -FilterXPath "*[System[EventID=3] and
EventData[Data[@Name='DestinationIp']='52.113.194.132']]"

ProviderName: Microsoft-Windows-Sysmon

TimeCreated                     Id LevelDisplayName Message
   -----------                     -- ---------------- -------
5/29/2023 6:30:24 PM             3 Information      Network connection
detected:...
5/29/2023 12:32:05 AM            3 Information      Network connection
detected:...
```

7. **Filtering events based on property values**

The `-Property *` parameter, when used with `Select-Object`, instructs the command to select all properties of the objects passed to it. In the context of the Get-WinEvent command, these properties will include all available information about the event. Let's see an example that will present us with all properties of Sysmon event ID 1 logs.


```
PS C:\Users\Administrator> Get-WinEvent -FilterHashtable
@{LogName='Microsoft-Windows-Sysmon/Operational'; ID=1} -MaxEvents 1 |
Select-Object -Property *


Message            : Process Create:
                     RuleName: -
                     UtcTime: 2023-06-03 01:24:25.104
                     ProcessGuid: {52ff3419-9649-647a-1902-000000001000}
                     ProcessId: 1036
                     Image: C:\Windows\System32\taskhostw.exe
                     FileVersion: 10.0.19041.1806 (WinBuild.160101.0800)
                     Description: Host Process for Windows Tasks
                     Product: Microsoft® Windows® Operating System
                     Company: Microsoft Corporation
                     OriginalFileName: taskhostw.exe
                     CommandLine: taskhostw.exe -RegisterDevice -
ProtectionStateChanged -FreeNetworkOnly
                     CurrentDirectory: C:\Windows\system32\
                     User: NT AUTHORITY\SYSTEM
                     LogonGuid: {52ff3419-85d0-647a-e703-000000000000}
                     LogonId: 0x3E7
```

```
                     TerminalSessionId: 0
                     IntegrityLevel: System
                     Hashes:
MD5=C7B722B96F3969EACAE9FA205FAF7EF0,SHA256=76D3D02B265FA5768294549C938D3D
9543CC9FEF6927

4728E0A72E3FCC335366,IMPHASH=3A0C6863CDE566AF997DB2DEFFF9D924
                     ParentProcessGuid: {00000000-0000-0000-0000-
000000000000}
                     ParentProcessId: 1664
                     ParentImage: -
                     ParentCommandLine: -
                     ParentUser: -
Id                  : 1
Version             : 5
Qualifiers          :
Level               : 4
Task                : 1
Opcode              : 0
Keywords            : -9223372036854775808
RecordId            : 32836
ProviderName        : Microsoft-Windows-Sysmon
ProviderId          : 5770385f-c22a-43e0-bf4c-06f5698ffbd9
LogName             : Microsoft-Windows-Sysmon/Operational
ProcessId           : 2900
ThreadId            : 2436
MachineName         : DESKTOP-NU10MTO
UserId              : S-1-5-18
TimeCreated         : 6/2/2023 6:24:25 PM
ActivityId          :
RelatedActivityId   :
ContainerLog        : Microsoft-Windows-Sysmon/Operational
MatchedQueryIds     : {}
Bookmark            :
System.Diagnostics.Eventing.Reader.EventBookmark
LevelDisplayName    : Information
OpcodeDisplayName   : Info
TaskDisplayName     : Process Create (rule: ProcessCreate)
KeywordsDisplayNames : {}
Properties          : {System.Diagnostics.Eventing.Reader.EventProperty,
                     System.Diagnostics.Eventing.Reader.EventProperty,
                     System.Diagnostics.Eventing.Reader.EventProperty,
                     System.Diagnostics.Eventing.Reader.EventProperty...}
```


Let's now see an example of a command that retrieves `Process Create` events from the `Microsoft-Windows-Sysmon/Operational` log, checks the parent command line of each event for the string `-enc`, and then displays all properties of any matching events as a list.

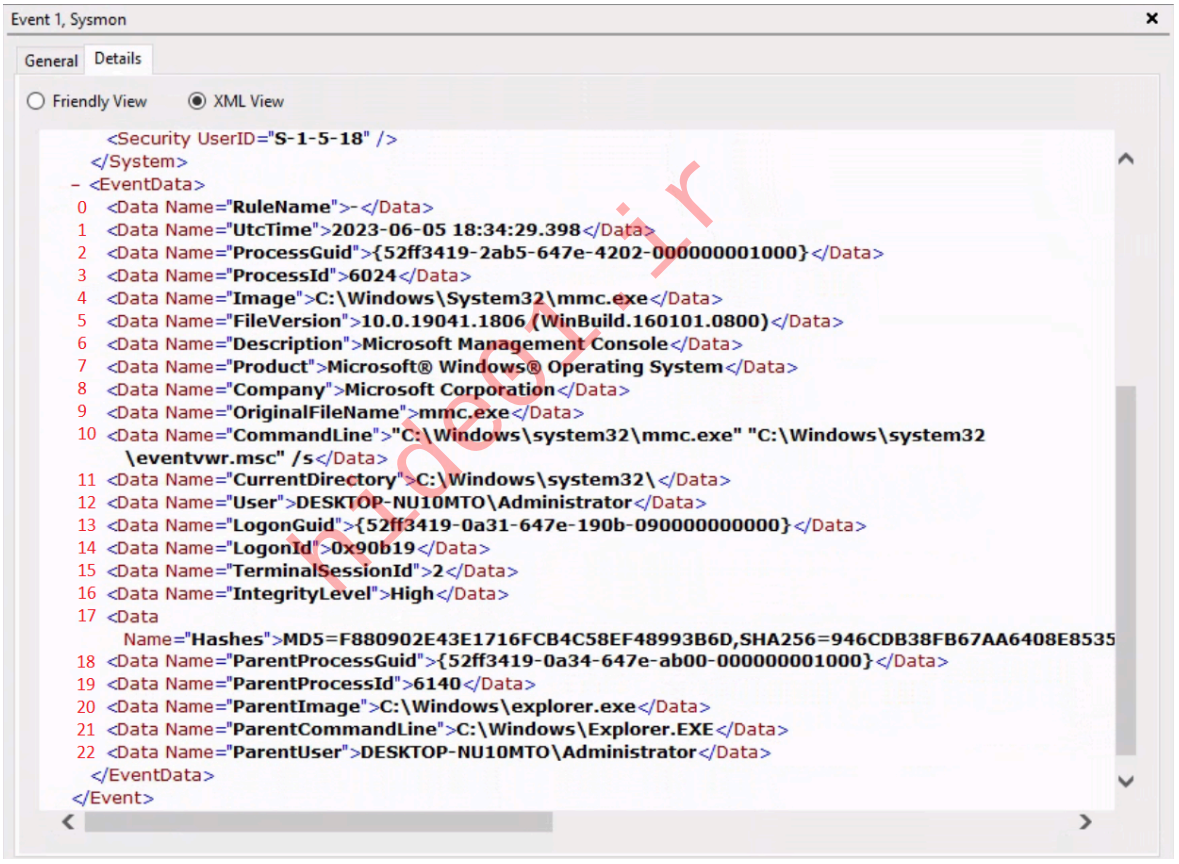
```
PS C:\Users\Administrator> Get-WinEvent -FilterHashtable
@{LogName='Microsoft-Windows-Sysmon/Operational'; ID=1} | Where-Object
{$_.Properties[21].Value -like "*-enc*"} | Format-List

TimeCreated  : 5/29/2023 12:44:58 AM
ProviderName : Microsoft-Windows-Sysmon
Id           : 1
Message      : Process Create:
               RuleName: -
               UtcTime: 2023-05-29 07:44:58.467
               ProcessGuid: {52ff3419-57fa-6474-7005-000000000c00}
               ProcessId: 2660
               Image:
C:\Windows\Microsoft.NET\Framework64\v4.0.30319\csc.exe
               FileVersion: 4.8.4084.0 built by: NET48REL1
               Description: Visual C# Command Line Compiler
               Product: Microsoft® .NET Framework
               Company: Microsoft Corporation
               OriginalFileName: csc.exe
               CommandLine:
"C:\Windows\Microsoft.NET\Framework64\v4.0.30319\csc.exe" /noconfig
/fullpaths
               @"C:\Users\ADMINI~1\AppData\Local\Temp\z5erlc11.cmdline"
               CurrentDirectory: C:\Users\Administrator\
               User: DESKTOP-NU10MTO\Administrator
               LogonGuid: {52ff3419-57f9-6474-8071-510000000000}
               LogonId: 0x517180
               TerminalSessionId: 0
               IntegrityLevel: High
               Hashes:
MD5=F65B029562077B648A6A5F6A1AA76A66,SHA256=4A6D0864E19C0368A47217C129B075
DDDF61A6A262388F9D2104
               5D82F3423ED7,IMPHASH=EE1E569AD02AA1F7AECA80AC0601D80D
               ParentProcessGuid: {52ff3419-57f9-6474-6e05-000000000c00}
               ParentProcessId: 5840
               ParentImage:
C:\Windows\System32\WindowsPowerShell\v1.0\powershell.exe
               ParentCommandLine:
"C:\Windows\System32\WindowsPowerShell\v1.0\powershell.exe" -NoProfile
               -NonInteractive -ExecutionPolicy Unrestricted -
EncodedCommand JgBjAGgAYwBwAC4AYwBvAG0AIAA2ADUAMAAwADEAIA

A+ACAAJABuAHUAbABsAAoAaQBmACAAKAAkAFAAUwBWAGUAcgBzAGkAbwBuAFQAYQBiAGwAZQAu
AFAAUwBWAGUAcgBzAGkAbwBuACAALQ

BsAHQAIABbAFYAZQByAHMAaQBvAG4AXQAiADMALgAwACIAKQAgAHsACgAnAHsAIgBmAGEAaQBs
AGUAZAAiADoAdAByAHUAZQAsACIAbQ

BzAGcAIgA6ACIAQQBuAHMAaQBiAGwAZQAgAHIAZQBxAHUAaQByAGUAcwAgAFAAbwB3AGUAcgBT
```

```
AGgAZQBsAGwAIAB2ADMALgAwACAAbw

ByACAAbgBlAHcAZQByACIAfQAnAAoAZQB4AGkAdAAgADEACgB9AAoAJABlAHgAZQBjAF8AdwBy
AGEAcABwAGUAcgBfAHMAdABvACAAPQ

AgACQAaQBuAHAAdQB0ACAAfAAgAE8AdQB0AC0AUwB0AHIAaQBuAGcACgAkAHMAcABsAGkAdABf
AHAAYQByAHQAcwAgAD0AIAAkAGUAeA

BlAGMAXwB3AHIAYQBwAHAAZQByAF8AcwB0AHIALgBTAHAAbABpAHQAKABAACgAIgBgADAAYAAw
AGAAMABgADAAIgApACwAIAAyACwAIA

BbAFMAdABvAGkAbgBnAFMAcABsAGkAdABPAHAAdABpAG8AbgBzAF0AOgA6AFIAZQBtAG8AdgBl
AEUAbQBwAHQAeQBFAG4AdABvAGkAZQ

BzACkACgBJAGYAIAAoAC0AbgBvAHQAIAAkAHMAcABsAGkAdABfAHAAYQByAHQAcwAuAEwAZQBu
AGcAdABoACAALQBlAHEAIAAyACkAIA

B7ACAAdABoAHIAbwB3ACAAIgBpAG4AdgBhAGwAaQBkACAAcABhAHkAbABvAGEAZAAiACAAfQAK
AFMAZQB0AC0AVgBhAHIAaQBhAGIAbA

BlACAALQBOAGEAbQBlACAAagBzAG8AbgBfAHIAYQB3ACAALQBWAGEAbAB1AGUAIAAkAHMAcABs
AGkAdABfAHAAYQByAHQAcwBbADEAXQ

AKACQAZQB4AGUAYwBfAHcAcgBhAHAAcABlAHIAIAA9ACAAWwBTAGMAcgBpAHAAdABCAGwAbwBj
AGsAXQA6ADoAQwByAGUAYQB0AGUAKA

AkAHMAcABsAGkAdABfAHAAYQByAHQAcwBbADAAXQApAAoAJgAkAGUAeABlAGMAXwB3AHIAYQBw
AHAAZQByAA==
              ParentUser: DESKTOP-NU10MTO\Administrator

TimeCreated  : 5/29/2023 12:44:57 AM
ProviderName : Microsoft-Windows-Sysmon
Id           : 1
Message      : Process Create:
               RuleName: -
               UtcTime: 2023-05-29 07:44:57.919
               ProcessGuid: {52ff3419-57f9-6474-6f05-000000000c00}
               ProcessId: 3060
               Image: C:\Windows\System32\chcp.com
               FileVersion: 10.0.19041.1806 (WinBuild.160101.0800)
               Description: Change CodePage Utility
               Product: Microsoft® Windows® Operating System
               Company: Microsoft Corporation
               OriginalFileName: CHCP.COM
               CommandLine: "C:\Windows\system32\chcp.com" 65001
               CurrentDirectory: C:\Users\Administrator\
               User: DESKTOP-NU10MTO\Administrator
               LogonGuid: {52ff3419-57f9-6474-8071-510000000000}
               LogonId: 0x517180
               TerminalSessionId: 0
```

```
                IntegrityLevel: High
                Hashes:
MD5=33395C4732A49065EA72590B14B64F32,SHA256=025622772AFB1486F4F7000B70CC51
A20A640474D6E4DBE95A70
                BEB3FD53AD40,IMPHASH=75FA51C548B19C4AD5051FAB7D57EB56
                ParentProcessGuid: {52ff3419-57f9-6474-6e05-000000000c00}
                ParentProcessId: 5840
                ParentImage:
C:\Windows\System32\WindowsPowerShell\v1.0\powershell.exe
                ParentCommandLine:
"C:\Windows\System32\WindowsPowerShell\v1.0\powershell.exe" -NoProfile
                -NonInteractive -ExecutionPolicy Unrestricted -
EncodedCommand JgBjAGgAYwBwAC4AYwBvAG0AIAA2ADUAMAAwADEAIA

A+ACAAJABuAHUAbABsAAoAaQBmACAAKAAkAFAAUwBWAGUAcgBzAGkAbwBuAFQAYQBiAGwAZQAu
AFAAUwBWAGUAcgBzAGkAbwBuACAALQ

BsAHQAIABbAFYAZQByAHMAaQBvAG4AXQAiADMALgAwACIAKQAgAHsACgAnAHsAIgBmAGEAaQBs
AGUAZAAiADoAdAByAHUAZQAsACIAbQ

BzAGcAIgA6ACIAQQBuAHMAaQBiAGwAZQAgAHIAZQBxAHUAaQByAGUAcwAgAFAAbwB3AGUAcgBT
AGgAZQBsAGwAIAB2ADMALgAwACAAbw

ByACAAbgBlAHcAZQByACIAfQAnAAoAZQB4AGkAdAAgADEACgB9AAoAJABlAHgAZQBjAF8AdwBy
AGEAcABwAGUAcgBfAHMAdABkAHIAcAA

AgACQAaQBuAHAAdQB0ACAAfAAgAE8AdQB0AC0AUwB0AHIAaQBuAGcACgAkAHMAcABsAGkAdABf
AHAAYQByAHQAcwAgAD0AIAAkAGUAeA

BlAGMAXwB3AHIAYQBwAHAAZQByAF8AcwB0AHIALgBTAHAAbABpAHQAKABAACgAIgBgADAAYAAw
AGAAMABgADAAIgApACwAIAAyACwAIA

BbAFMAdABkAGkAbgBnAFMAcABsAGkAdABPAHAAdABpAG8AbgBzAF0AOgA6AFIAZQBtAG8AdgBl
AEUAbQBwAHQAeQBFAG4AdAByAGkAZQ

BzACkACgBJAGYAIAAoAC0AbgBvAHQAIAAkAHMAcABsAGkAdABfAHAAYQByAHQAcwAuAEwAZQBu
AGcAdABoACAALQBlAHEAIAAyACkAIA

B7ACAAdABoAHIAbwB3ACAAIgBpAG4AdgBhAGwAaQBkACAAcABhAHkAbABvAGEAZAAiACAAfQAK
AFMAZQB0AC0AVgBhAHIAaQBhAGIAbA

BlACAALQBOAGEAbQBlACAAagBzAG8AbgBfAHIAYQB3ACAALQBWAGEAbAB1AGUAIAAkAHMAcABs
AGkAdABfAHAAYQByAHQAcwBbADEAXQ

AKACQAZQB4AGUAYwBfAHcAcgBhAHAAcABlAHIAIAA9ACAAWwBTAGMAcgBpAHAAdABCAGwAbwBj
AGsAXQA6ADoAQwByAGUAYQB0AGUAKA

AkAHMAcABsAGkAdABfAHAAYQByAHQAcwBbADAAXQApAAoAJgAkAGUAeABlAGMAXwB3AHIAYQBw
AHAAZQByAA==
                ParentUser: DESKTOP-NU10MTO\Administrator
```

```
    --- SNIP ---
```

- `| Where-Object {$_.Properties[21].Value -like "*-enc*"}` : This portion of the command further filters the retrieved events. The '|' character (pipe operator) passes the output of the previous command (i.e., the filtered events) to the 'Where-Object' cmdlet. The 'Where-Object' cmdlet filters the output based on the script block that follows it.
  - `$_` : In the script block, $_ refers to the current object in the pipeline, i.e., each individual event that was retrieved and passed from the previous command.
  - `.Properties[21].Value` : The `Properties` property of a "Process Create" Sysmon event is an array containing various data about the event. The specific index `21` corresponds to the `ParentCommandLine` property of the event, which holds the exact command line used to start the process.



  - `-like "*-enc*"` : This is a comparison operator that matches strings based on a wildcard string, where `*` represents any sequence of characters. In this case, it's looking for any command lines that contain `-enc` anywhere within them. The `-enc` string might be part of suspicious commands, for example, it's a common parameter in PowerShell commands to denote an encoded command which could be used to obfuscate malicious scripts.
  - `| Format-List` : Finally, the output of the previous command (the events that meet the specified condition) is passed to the `Format-List` cmdlet. This cmdlet displays the properties of the input objects as a list, making it easier to read and analyze.

Practical Exercise

Navigate to the bottom of this section and click on `Click here to spawn the target system!`

Then, RDP to `[Target IP]` using the provided credentials and answer the question below.

```
xfreerdp /u:Administrator /p:'HTB_@cad3my_lab_W1n10_r00t!@0' /v:[Target IP] /dynamic-resolution
```

Skills Assessment

To keep you sharp, your SOC manager has assigned you the task of analyzing older attack logs and providing answers to specific questions.

Navigate to the bottom of this section and click on `Click here to spawn the target system!`

RDP to `[Target IP]` using the provided credentials, examine the logs located in the `C:\Logs\*` directories, and answer the questions below.

```
xfreerdp /u:Administrator /p:'HTB_@cad3my_lab_W1n10_r00t!@0' /v:[Target IP] /dynamic-resolution
```